Computerworld

Extra!

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We have striven to capture the immediacy, the diversity and the excitement of the software industry in this issue of *Computerworld Extra!* Your thoughts and comments on how well we've succeeded are important.

EXTRA

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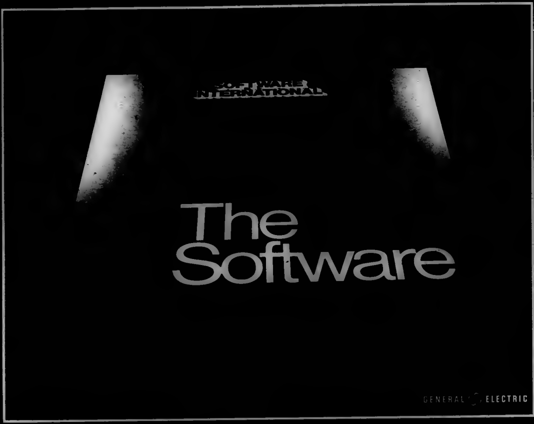

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DECISION SUPPORT SYSTEMS

CLEARLY EXPLAINED

Data processing professionals are in serious trouble. After 20 years of promising corporate management that the computer will make decision making infinitely easier and more effective, only a few in DP have delivered. The vast majority have not, thus creating a growing crisis for the entire DP industry.

DP's shortcoming has become more acutely noticeable during this period of severe recession and heightened business competition, precisely the time when management decision making is more critical than ever. Yet most DP departments continue to concentrate on means of generating information rather than on utilizing it, which is all that management does. As a

By Walter E. Lankau

PHOTOGRAPHY BY JACK ROCHESTER.

result, many DP professionals are now viewed with distrust, overloaded with backlog and rapidly losing influence with the corporate hierarchy, both in terms of prestige and budgets. Management, meanwhile, is finding alternatives to filling its needs on its own, thus accelerating DP's crisis.

Like the fellow straddling two ice floes, DP faces nothing but icy peril as it divides itself between production work and management's needs. Yet a solution is at hand — the new technology of full-scale decision support systems (DSS). While many progressive DP executives are adopting DSS, with dramatic results, too many are either ignoring the technology or are only beginning to perceive its significance. If this myopia continues, there is little ahead for DP except icy peril.

The problems are obvious. A study of DP departments by IBM indicates that in major companies there is an average 2½-year backlog for major types of applications, and 15% of the respondents reported backlogs in excess of four years. The message is clear: DP departments are swamped with work and sinking deeper.

Resource Allocation

Another aspect of DP's situation is that it has failed to heed management's demands, instead putting its budget dollars in lower level operations. A recent study by a major consulting firm of DP resource allocation shows that about $30 billion of DP funds goes to support $450 billion of managerial/professional activities, while $50 billion of DP dollars goes for support of $150 billion of clerical activities. That's a 15:1 ratio for management vs. 3:1 for nonmanagement. What this says is that most of DP's resources (which DP itself requests and budgets) are directed at such clerical assistance as online data entry, word processing and large-scale transaction processing, with a disproportionate amount going to higher level utilization and analysis of data.

There is no shortage of evidence that management wants and is demanding more computer assistance for the more complex decision making required in business today. After two decades of waiting and hearing promises, it is growing more frustrated and angry, especially since it foots the bills for data processing. As the chief executive officer of a major food products company recently told his DP director, who was requesting a trial of a DSS, "I don't want you coming back and telling me that what we need is more data. Every time there's a problem, people come back and say, 'The answer is for us to purchase additional data.' We've got information coming out of our ears and what we need now is some way to make sense of it!"

Further insight into what management wants comes from a study done at MIT and supported by the Center for Information Systems Research. The point of the study was to find a correlation between what DP departments do and what managerial end users really want them to do. Nineteen different major firms in various industries participated, and more than 1,000 people in all levels of management responded.

The survey showed that both DP and managerial end users agreed on what DP should be doing in terms of priorities — communications with managerial users, efficiency of hardware utilization, lessening of hardware and systems downtime, training programs for users and data security and privacy. The bad news for DP came from the agreement by both sides that DP wasn't performing well in areas that were the most important to managerial end users:

- Responsiveness to user's needs.
- Development of more analysis systems.
- Development of more DSS.

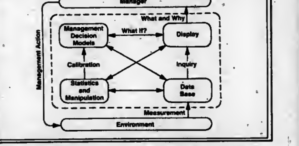
In short, DP is not doing what its most important customer thinks is important.

This kind of academic finding only serves to support a real-world phenomenon: end users — executives and decision-making managers — are voting with their budgets. In a growing number of companies, there is a dramatic shift of computer resource dollars being turned over directly to end users and being taken away from DP. The power, influence and usefulness once held by DP is either being eroded slowly or stripped away rapidly, depending upon the company. In either case, there stands DP straddling the ever-widening ice floes.

Toys in the Executive Suite

Unable to stop the erosion, data processing has begun promoting the use of personal computers among managers. Clearly, personal computers are a low-cost-per-unit tool (although not that inexpensive on a cost-per-user basis when compared to a mainframe or mini system). They have a lot of pizzaz, some clever software and good graphics, all of which give the manager a sense of utility and activity. And they have provided the DP industry with a major benefit in educating non-computer-oriented types in the ease and power of the computer.

But personal computers in no way help solve DP's major problems. They are nothing more than powerful calculators. They affect only small problems. They have limited power, a basic incompatibility problem and limited ability to handle



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data, especially when integration of data from various sources is needed. Ultimately there is a control problem with personal computers in a major company — everyone ends up having his own little data base, which defies good quality control and standards. In the end, the personal computer for managers is a short-term, stop-gap solution that creates problems rather than solutions..

Information Center

Then there's what IBM calls the Information Center concept, which really is just another term for in-house time-sharing. It, too, is inadequate for serving top management's needs in today's hectic business world. IBM says that "the mission [of the Information Center] is to provide end users with tools and techniques to allow them to access their data on their terms." The system indeed increases user productivity because managers no longer have to go to the end of the line to get their hands on the computer or the corporate data base. A company with an Information Center certainly gives end users more data handling and computational power than with personal computers. And the Information Center can be quite cost-effective compared with traditional programming approaches, according to IBM. Last, it will indeed help reduce DP's backlog.

But the Information Center was not designed to meet management's primary need of analysis utilizing a comprehensive and integrated system. First, Information Centers run into integration problems because of the potpourri of single-purpose programs IBM and others provide without a capability of integrating them. As the user's problems grow more complex, he inevitably has to go back to the DP department to get help with integration, thereby adding to the department's work load and backlog.

For instance, in the area of information retrieval (such as government reports, travel expenses and insurance claim analysis), IBM suggests products like GIS, Stairs and QBE. For reports and graphics (for example,. mortgage systems, inventory control, management reports), it suggests ADRS, GDDM, Chart and GIS. For data analysis (forecasting, point-of-sale analysis, marketing research) it suggests APL and AIS and for modeling (budgeting, operations statements, plan vs. actual), it offers Plancode and FPS. That makes 11 different products, and the question (and problem) is who is going to be responsible for all of the integration and interfaces that have to be built. The answer certainly isn't, or shouldn't be, the end user.

For Some, Not All

A secondary problem with the Information Center is in its concept of serving many users, in effect saying, "Here it is, come and get it." That won't work without substantial professional support. At one company that adopted an Information Center, more than 800 managers began using the system, with four DP professionals as the support staff. It's obvious that no user is going to get the much-needed support for critical computer operations when he has to compete with 800 others.

The conclusion one comes to after analyzing these two answers to the management vs. DP crisis is that they aren't answers at all. Personal computers and Information Centers — or in-house time-sharing — are helpful, unquestionably. They help stem the backlog tide or maybe even reduce it somewhat. They will increase the productivity of the end user, undoubtedly. But they really don't satisfy the system requirements of DP's most important clients — executives, support staff and decision-making managers.

An Answer

A growing number of progressive DP professionals have gone beyond personal computers and Information Centers to employ sophisticated, full-scale DSS. While there is much confusion over what constitutes a DSS, the full-scale DSS is easily identified by five basic capability characteristics:

- *Fully integrated, multiple-source data base.* A management system obtains critical information from a variety of sources — data about the economy from various government and private providers; merger and acquisition data from Compustat; syndicated data on markets and products; and all types of internal and external information on marketing, finance and operations. All this comprises a DSS data base, which by definition must be large and tightly integrated to provide real benefit to management.
- *Ad hoc analysis.* Management has to be reactive, making immediate short-term and long-term decisions based on the information and tools at hand. Their world is based on ad hoc analysis, not on production systems. Many companies that have adopted

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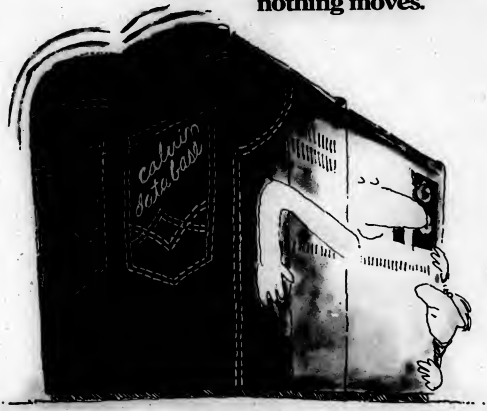

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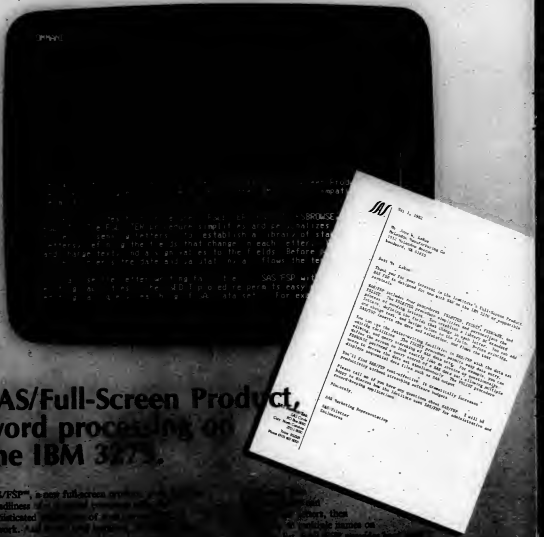

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full-scale DSS report that as much as 80% of the usage is employed for ad hoc analysis and reports — addressing questions and problems that come up that day or that week. The other 20% is utilized for producing consolidations and standard reports.

- *Modeling.* Because managers are principally concerned with the future and the implications of today's decisions, they must have modeling capabilities at hand so as to grasp and manage the workings of their business environment. Put another way, managers deal with analysis, not reporting. For example, a lower level marketing manager wants to know what sales were in Los Angeles last month. That's a retrieval question and the answer is obtained routinely by querying the data base. But a marketing executive typically needs answers to such questions as, "What sales did we lose in Los Angeles when our competitor introduced its new product last quarter?" There is no such answer and no such information in the data base, yet the answer is critical to the executive's work. With a full-scale DSS, the answer is obtained by building a small model to approximate what sales would have been, what they actually were and what the loss was. That is analysis that only a DSS can provide.
- *Rapid cross-functional communication.* Management's perspectives and problems are global. All decision makers need information from across the corporate spectrum of marketing, sales, finance and operations and down through operational levels. In order to analyze all these areas meaningfully, the manager must have data, models and analysis from each area, all coordinated and unified. And he must have them now — today — not 2½ years from now.
- *User-friendliness.* The ultimate end user of a DSS is a manager or an executive, not a computer programmer. A growing number of chief executive officers have actually begun using computers themselves over the last 10 years. Their staff people are even more active, providing chief executive officer support by translating his requests into business terms and then into computer terms. Thus, there is growing demand for easy-to-use, English-based DSS, especially with the advent of the personal computer and sophisticated micro programs for business.

DSS Components

To make these five characteristics come alive, a true or full-scale DSS must have several components. First, a fully integrated system must have data gathering utilities and powerful data base management tools because the needed information comes from all over in various sizes and shapes — time series, data base management systems, finance, marketing and economic. A DSS must be able to capture all the data and put it into a flexible data base environment.

Second, a true DSS has to have very powerful ad hoc display and graphics capabilities because visual presentations and graphic manipulation have become standard for managers. Third, the DSS must have statistical tools available because the necessary answer can come only from massaging and manipulating the data — adding, subtracting, multiplying, dividing, ratios or regression coefficients. Last, it must have modeling tools incorporated in the system — such as financial statement simulators, risk analysis and forecasting.

Schematically, a full-scale DSS should look like that represented in the figure on Page 6.

What Is It?

There is considerable confusion over DSS because of the spiraling growth of software and hardware and the adoption of the term DSS by many vendors, making it the latest buzzword. The confusion is compounded by the fact that just about any product can correctly call itself a decision support system, in the narrow sense of the term. A hand-held calculator does indeed support decision making, as does much of the personal computer software, mini and mainframe application packages and special-purpose systems designed for functional specialties.

Many are very good, but they do not meet management's full-scale decision-making needs. Data base management systems, for example, are basically designed for retrieval, not analysis. They do have strong data base capabilities and many of them have good reporting capabilities, but they tend to be limited and very rigid in structure, with little or no modeling or analytic capability. Also considered DSS by some are the line-item modeling languages, but they fall short both in not having the data base management capability needed to handle large and complex problems and in requiring very extensive coding.

As mentioned earlier, an increasing number of major corporations have employed full-scale DSS, with substantial results. Nationwide Insur-

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ance Co., for example, has a DSS designed specifically to support the president and his staff. There is a corporate strategic planning model, with regional models to deal with the special issues of each region and state in which the company operates.

Insurance being a very complex and dynamic business, Nationwide's DSS has given the company unprecedented control and power. For example, in its strategic financial evaluation model, data has to be entered and unified by broad classifications of life, health and property insurance and then broken down into groups, individual products and components of these products. In addition, there is a special time dimension, a geographic dimension and specialized marketing and financial data. The entire DSS was implemented in six months.

Another case is a major oil company's marketing subsidiary, which has been employing high-level decision support system technology for almost five years with remarkable results. The DSS was used initially to determine, for the first time, the profitability of thousands of service stations. With that information in hand, the company was able to select and close the unprofitable units. This grew into a companywide system that serves high-level decision making through analysis of retail outlet budgeting and profitability, performance tracked by various channels of distribution, distributor profitability, cash planning and long-range planning.

Perhaps the greatest test and proof of the oil company'a DSS came three years ago when it decided to reorganize marketing operations and to reduce the number of divisions from 12 to five. This meant reconsolidating an enormous amount of data, completely redoing the financial system to back-cast what the new organization would have looked like before and to project budgets of the new entities. The total reorganization was done over a weekend, with all reports on top management's desks Monday morning. It would have taken a minimum of six months to do the same without the power and flexibility of the DSS.

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Westinghouse Corp. has taken an office-of-the-future view of integrating comprehensive decision support system capabilities with word processing and electronic mail for the purpose of serving the entire corporate Controllers' Group in its management of 200 profit centers worldwide. Financial data flows from worldwide operations bottom to top and is fully integrated in one common environment. Each manager has a terminal on his desk and can rapidly consolidate and analyze data before sending it forward. At month's end, financial reports that used to take weeks now take hours, giving superiors much needed time for analysis and questioning before forwarding the information to the top.

At the top level of Northwest Industries is its president, Ben Heinemann, who is a hands-on everyday user of that company's DSS. The Executive Decision Support System has an extremely comprehensive data base that supports a number of functions; it also has on-line access to approximately 8G bytes of information. The company has budgeted actual forecasts and planned information for 200 line items for all of the nine companies that Northwest Industries owns.

Heinemann himself uses the system for more than just reports. Drawing on the data base and utilizing the statistical tools and models through his desktop terminal, he engages in sophisticated corporate analysis, directing his senior staff in financial and operational planning, strategic planning, forecasting and econometric planning.

Summary

In summary, DP professionals indeed face a difficult situation, not all of their own making. Yet the difficulties and crises can be resolved. The objective is to eliminate the mounting backlog problems, regain the influence and control they once had and finally fulfill the promise the computer holds for an increasingly restive management. Personal computers, Information Centers and full-scale decision support systems all have a place in the world of information management. But only through a comprehensive and flexible full-scale DSS, adopted by DP departments and its power placed in the hands of management, can the objective be achieved and DP's crisis be eliminated.

Lankau is vice-president in charge of decision support systems at Management Decision Systems, Inc., in Waltham, Mass., where he has worked since 1972. He holds an MBA from the Wharton School of Finance, University of Pennsylvania.

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Troubleshooting	3.0	2.8	2.8	3.3	2.8	2.6
Documentation	3.1	2.8	2.8	3.1	2.8	2.7
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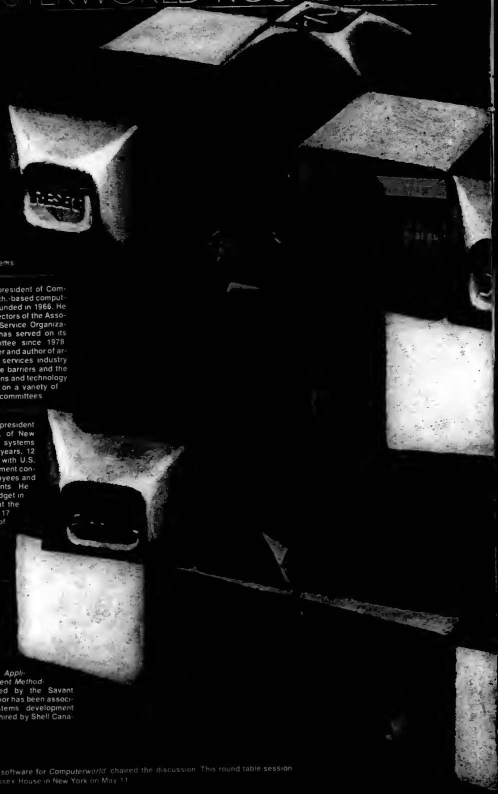

[illegible] L. McCLURE [illegible] own consulting fir[illegible] [illegible] McClure & Associates Inc in Chicago, and [illegible] an assistant professor of decision sciences at Northwestern University. She is a guest speaker this year with the James Martin World Seminar. McClure is coauthor (with Martin) of a two-volume work entitled *Maintenance of Computer Programming*. This book and her consulting efforts for the last three years have centered on software maintenance and legal problems.

RICHARD L. CRANDALL is president of Comshare, Inc., an Ann Arbor, Mich.-based computer services firm that he cofounded in 1966. He has been on the board of directors of the Association of Data Processing Service Organizations, Inc. since 1974 and has served on its long-range planning committee since 1978. Crandall is a frequent speaker and author of articles concerning computer services industry issues, such as foreign trade barriers and the economic impact of recessions and technology trends. He has also served on a variety of U.S. governmental advisory committees.

JOSEPH E. ALLARD is vice-president of United States Trust Co. of New York. Allard has worked in systems development for nearly 20 years, 12 of which have been spent with U.S. Trust. At present, his department consists of 64 permanent employees and approximately 21 consultants. He has an annual operating budget in excess of $6 million and, at the time of our meeting, had 17 projects at various stages of development. He explained that the development process at U.S. Trust consists generally of a combination of options.

DENIS CONNOR is manager of administrative services of the Information Systems Development and Processing Branch of the Toronto-based Workmen's Compensation Board. He joined this organization in 1968 and assumed his present position in. His book, *Application Systems Development Methodologies* will be published by the Savant Institute this summer. Connor has been associated with computer systems development since 1967 when he was hired by Shell Canada as a systems analyst.

LOIS PAUL, senior editor software for *Computerworld*, chaired the discussion. This round table session was held at the Mariott Essex House in New York on May 11.

EXTRA

Managing a DP installation is like trying to solve Rubik's Cube: both tasks involve a series of decisions that can lead to either a successful, well-ordered organization or a seemingly endless maze of detours and unfinished projects. The trick is to evaluate the puzzle in advance, charting a logical path to the solution that will avoid frustrating dead ends.

Each day, the DP manager is faced with decisions that involve making the most of his current resources. His choices will critically affect the entire organization. Wedged between increasingly demanding user departments and upper management, which more often than not is bottom-line-oriented, the DP manager is charged not only with holding the line on current projects, but also with increasing productivity without taking an extra bite out of his limited budget. The DP manager can take a number of roads; each requires careful evaluation and planning. He must ask himself some of the following: When should you rely on internal software development? When is a packaged solution appropriate? How do you justify bringing in a consultant or contract programmer? How do you determine if time-sharing or contracting with a computer services company is preferable to buying or renting additional hardware?

Although no one has all the answers, we, like the guides to solving Rubik's Cube, have attempted to offer insight into the solution — in our case, to the constant battle of optimizing the DP resource. We went right to the source — a DP manager — and asked him how he copes with these situations. Then we invited three experts in the software field to share their ideas and concerns, with the hope of coming up with some solutions or recommendations.

How do you decide which way to go at the start of a new project?

Allard: You've got to look at it from a bottom-line standpoint — questions like what is it going to cost to build it and to package it? You make a business decision, and you make it with the user.

You can't let egos get in the way and insist on building everything yourselves. We will always try to have a package, if it exists. That will be one of the first things we look at.

Then there is time-sharing to consider. We have gone out and used a time-sharing service in two situations: when we project low-volume use and low cost on an available service and when a service we want is available only in a time-sharing environment. In either case, my objective is to get the job done as cheaply as I can.

McClure: When it comes to these various options, we can't tell you what the best thing is to do. We can tell you what some of the worst things are, and maybe that is a start. One of the worst things you can do is to stop and lock yourself into a technology that is going to be difficult to modify. If you stop looking at alternatives, you've got a problem.

Connor: I agree with that completely. Once you say I am going to work only this way or follow this particular technique and you cast this decision in concrete, basically you're sunk. You have to be completely flexible in terms of how you are going to solve your DP lems. The solutions you choose must depend entirely on how the problems are spelled out in terms of your organization. There are no two cures that are going to be the same. There are no pat answers. There are no pat methodologies and techniques.

McClure: I heard a very funny story about the president of Yale University going to a seminar about fourth-generation languages where they talked about 30-fold increases in productivity and all sorts of things. The president of Yale really picked up on this and he went back to Yale and said from then on all future development would be done only in Focus. And I thought, that's probably just as bad as where they were before.

Suppose an organization has not done any real development for five years and they want to start development now. How should they go about it?

Crandall: When you talk about the need for a corporate data base and you don't have one and you have no strategy for data structuring, that is the ideal kind of environment for bringing in a computer service organization. This type of firm offers well-tested software, distributed support forces situated close to the end users and the experience of actually installing applications quickly so users can see real results. It provides further motivation within the organization to clean up the bad data sources because you now see what the deliverables are. The most profitable thing you can do is get a computer service company dangling in the end of the line. Get a contract that they are going to implement something and use them until they get tired.

Do you ever contract an entire job out to a firm?

Allard: I've considered it when I thought they could do a better job than I could. For this type of approach, I'll establish an internal project management to work with them. I want to make sure they are meeting their commitments and delivering.

When does the pendulum swing in favor of in-house system development?

Allard: When we can't find the package and there is no time-sharing alternative, or when the cost is prohibitive.

We go through a definition phase. One technique we use is to move away from written user specifications and instead generate what we call scenarios. This is a series of screens that show the users how the project will work. One we did recently for our security movement system is 1,500 screens. It took only a few weeks to put the whole thing together. Basically, it allowed us to start at the top and show the user how the security movement system is going to work. So the users understood, whereas they would never have understood with a document.

After you deliver the system, do users ever say it isn't what they really expected?

Allard: Not since we've been using this approach. That's the problem you have when you generate a lot of specs, because they are just not going to read it. And if they read it, they're not going to understand it.

Crandall: Say, for example, you had a 1960's general ledger and you decided you needed a newer kind. What would you do?

Allard: We have a system like that that is near and dear to us. We built it in the 1970s. We came to a situation in the late '70s and early '80s where there was a lot of data that wasn't being captured. In addition, there were a lot of requirements. The cost of modifying that system was prohibitive because it was written in a 1972 time frame when we were concerned about direct access space.

Now we are in a different time frame. Machines are many, many times faster and we are not so concerned about direct access space. So we bit the bullet and built the transaction system the user felt he needed. It has a much larger management information base and we have a large extract, so the user will be able to do his own information and retrieval.

What are some of the problems you face in dealing with programmers when you are developing software in-house?

Allard: Well, for one thing, I had a lot of trouble convincing people they had to get away from Assembler. There is a nice tight code, efficient stuff that they understood. And you had to move them into languages and methodology. Now I see the same thing happening again, with

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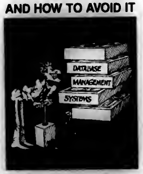

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Cobol and other languages. We want to start generating a lot of the code. There is a lot of resistance to this. But you have got to take risks as you go along and be ready to change as soon as something doesn't work. I think that is where I have seen a lot of failures in this business. People start something, it becomes an ego thing and they can't back off, even if it isn't working.

Crandall: But still, do you attach yourself to the bandwagon of a piece of software that has a development future, or do you start this — in some cases hopelessly expensive — process of changing it and revealing it every time the environment changes?

McClure: You have to look at components. Maybe looking at a payroll system you can't do, such as calculating the gross. But once you get the gross, the gross-to-net portion is standard and you use that portion.

Connor: But how is an organization going to plan for the future so it can build systems for the '80s or for the '90s? You can't just sit and wait for things to happen. I can't buy that.

Allard: You have to balance. It depends on the application and what it means to the business. It depends on the situation.

Crandall: That is kind of a technical strategy. The organizational strategy is to respond, as opposed to understanding the whole problem of need. I am not saying don't understand the whole problem, but don't block action until you have this whole plan developed. Otherwise you find you never get into action.

Connor: I agree with you completely, but I still feel you need an umbrella of some form so you can zero in on particular areas and see how they relate to one another.

Allard: I agree with Rick Crandall a little bit here. It is a question of understanding the needs. On the other hand, as Denis says, you do need some sort of overall umbrella so that from a high level you understand where you are going. You have got to be in a situation where you are delivering things fairly quickly and not accumulating these needs and saying "in three years we are going to give you this project." I am trying to set up my projects now so users can see a piece of it delivered in three months.

McClure: What Rick is saying is make that piece flexible because, no matter what, you are going to have to change. What James Martin is saying, I think, is that you have to develop the model.

Connor: Not in great detail.

McClure: But if you are going to bring it down enough, you can do a model in terms of the data model in about six months. But if you want to do a complete one, you are probably talking about a longer time and it can't wait.

Connor: You only need it to the level of detail where you are able to build modules so that these modules can fit later on — they can talk to one another.

Crandall: There you are talking about software technology, and those are two very different issues. Corporations change. Corporations become conglomerates and then they become single-product companies. I don't think a visionary chief executive or president could tell you where that company is going with its data systems. I think the challenge is to be able to produce solutions in an unstructured environment.

Allard: You must be sure that you keep enough flexibility. You don't want to get tied to one vendor. Anything could happen to that vendor. Putting all your eggs in one basket could prove to be very expensive.

Crandall: On the one side, the general ledger system is quickly passed off. In other areas, we say "Here is something relative to the whole industry." So you assume the predecessor systems have been working, and you presume you have some staff able to take it to its next generation.

McClure: You don't repeat the same mistakes you made in the past and you probably don't use the same technology. You probably don't want to use the same language.

Allard: Absolutely. There won't be any Assembler in this.

McClure: Priority of efficiency is different, and you are exercising flexibility and human engineering. You pick the tools to give you that kind of system.

Crandall: I think it is important

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that the software is changing as well. The reason we needed those technical people in the 1970s is that they were writing in the language. If you give someone a financial planning language today, it doesn't have to be too technical, but they have to know the financial discipline. You really can go out and do that. That is what the users want.

Allard: There is no way you can lay down a set of rules for all organizations. What is right for one organization is not right for another. It depends on where they are and where they want to go — if they want to go anywhere. Some companies are very happy with what they've got. Their transaction systems are in perfect shape. If a thing isn't broken you don't have to fix it. So it is very hard to say, "This is the methodology you apply." You have to study the situation.

How do you select contract programmers and how do these outsiders work with your own DP staff?

Allard: In terms of selecting those people, it is purely best person, best price. I don't care who supplies the contract programmers. What matters to me is the individual who is in there doing the work.

As far as interacting with my own people, a few years ago I thought of using a lot of independents and I was very concerned that this was going to cause me a problem with my own people. I thought everyone was going to come in and say, "I want to be an independent." Well, I tried it and it hasn't happened. I let it be known that if people really had their hearts set on being independent, I would discuss it with them. There weren't too many takers. In terms of the contract programmers themselves, I figure they are making more money than my regular people, and they are going to do whatever I want them to do. They are going to make the buck, but they are not necessarily going to have the interesting work.

When do you bring in a consultant?

Allard: When I'm looking for some specific expertise. The advantage this person affords me is an objective viewpoint. I want to make sure we take a wider view of everything. Right now I have a consultant looking at new methodologies for me. This is a new area and, frankly, there is so much going on in the area that it is more than I can comprehend. We need to set up a methodology department, perhaps, and I brought in a consultant to help me establish that department.

Is this the standard use for consultants, or are they often brought in at a crisis point or after a project has been tried and hasn't worked?

McClure: I think it depends on the organization. If an organization is entering new territory or considering a technology it hasn't used in the past, then I think it might be correct to bring in expertise in the beginning. Another way consultants are used is if you want to convince your management that you need something — more computer power or a training program for your people. You know this is the direction to go. Then you bring in the expert and you choose an expert who will basically . . .

Connor: . . . Agree with you.

McClure: . . . Who is your mouthpiece, yes, and you use the expert just to help you sell your idea. That is very effective.

Allard: It is kind of an expensive use.

Connor: But very effective.

Allard: I know that's a common use of consultants. In my situation, I'm working with a budget, and I do pretty much what I want within that. So it isn't a question of needing consulting to back me up, but it is a question of my presenting it in such a way that it makes business sense.

Crandall: Another approach an organization can take, among these options, is to utilize a sufficiently powerful and flexible software base and make each package small enough so that you can get it to market, so to speak, in the organization. You can evolve a system into at least something that has a data acquisition and management correspondence so your data is well integrated among those being utilized. What this approach requires is a model of the company's needs, and that takes a long time to specify.

Connor: You don't have to solve the problems of the whole organization all at once. You can come from the top and start to work out in detail in specific areas. You work from a

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data management base — not just data management in the sense of a data dictionary, but in terms of understanding the data associations and relationships within that particular area.

One of the first things that should be done is to be able to use some kind of data management system that will enable you to extract data, build a separate storage, which you could then use to provide spot systems. Having done that, you then use it as a base to further spell any new systems or modify the existing systems in terms of the particular data structure you have established.

How are the users involved when you have a new project and you are trying to decide how to handle it — whether to select in-house programming, a packaged solntion or other options?

Allard: In terms of the initial feasibility of the project, it is not strictly a user kind of thing. I will help a user to pick out a package if that is what he needs. It's also nice to be consulted by the user before he makes a decision. So I'll field questions like, "Are we going to get into a trap if we buy this package?" This is where I think the role of the DP manager has to go beyond building the standard systems. If every time a user wants something, we say, "You have to wait — maybe next year," eventually, they're not going to need us.

Are users resorting to hidden caches of micros to do the small jobs the DP department cannot get to?

Allard: We almost got to that point, but we basically made the personal computer an extension of our information center. We recently had an article in the company newspaper about how to buy a computer. Users come to us and we provide recommendations. It seems to be working out. We have several micros in the organization. I strongly feel that personal computers will eventually replace the terminals we use today.

Do you think the DP manager is generally the person who controls the use of microcomputers?

Allard: I don't think we are typical in that. However, the key is not to stop the users, but to work with them and help them to pick the right solution. Also, there is some strategy. We are trying to hook a whole network in and we see the IBM Personal Computer, perhaps, working in our overall strategy. We still have to get the data off the mainframe. That is really integral to the whole information center concept. Because very few of the applications run totally by themselves. So, if they want the data, we can get it for them and get it pretty quickly. And we'll do that. We'll do the extract. But once the data is there, I would like to be able to make a downlist of some of this and let them use some of their own tools at the personal computer level. The nice thing is that they are impacting themselves.

How is the information center working within your organization?

Allard: It's one of the very important trends I see — this whole concept of users doing a lot of their own work. We feel we're leading that effort from a systems development standpoint with our information center. We're out there teaching users how to program. The personal computer is a very important factor in this whole area. I can see a whole conventional system evolving out of this thing and, basically, it will be the guardian of the corporate base. We've got all this data all over the company. Somehow, we've got to make some sense out of it.

Crandall: I think the information center is before its time in relation to the available software technology. My guess is that there will be progress in the next decade.

Allard: I think the informa-

(Continued on Page 79)

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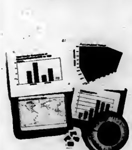

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CAN YOU KEEP A (TRADE) SECRET?

By G. Gervaise Davis III, Esq.

Remember when you were a kid, your friends used to say "Can you keep a secret?" No matter what you said, they would tell you the latest about some friend. You promptly told someone else all you had just heard "in secret." As a lawyer working daily with the software industry, I keep thinking that when the following scene happens to them, some of my DP friends may wish for the simple days of childhood :

You just left the office of the vice-president of marketing, who excitedly told you that the complex mar-

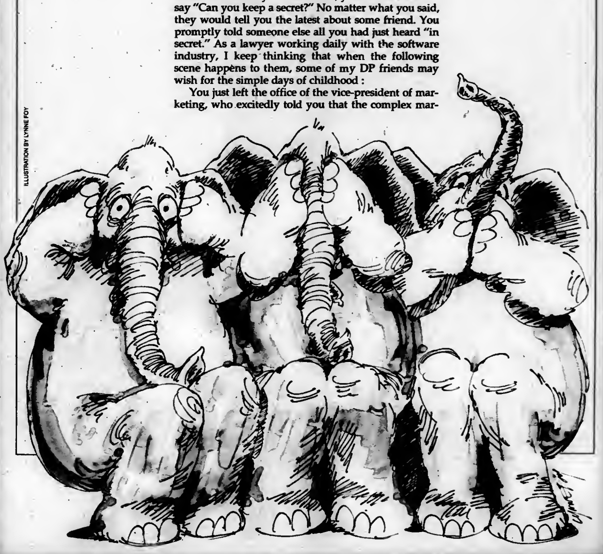

ILLUSTRATION BY LYNNE FOY

keting analysis program your department wrote for him last year is so good that the president has recommended to the board of directors that it be sold to one of those big software houses. They have offered to buy it for $250,000 plus continuing royalties, but, of course, they want exclusive worldwide rights to it.

The vice-president was concerned, however, because he had heard that the programmer who wrote most of it left last month for a job with a big time-sharing company in California. "That won't create any problem, will it?" he asked. As you backed out his office door, meekly muttering, "No, I sure hope not," you wondered a bit about the situation.

On the way back to your office, you think how clever you were, what with the turnover in programming staff, to have insisted on the use of top-down structured programming techniques. You even sent the documentation back a couple of times because the program wasn't commented the way you felt it should be. Certainly ought to be easy to turn it over to them and easy for them to maintain, you think. Things are in pretty good shape, you remember saying to yourself.

As you arrive in your department, you vaguely remember something Joe, the departed programmer, said about how impressed the time-sharing company was with the work he told them he had done on the marketing analysis program. You were frustrated at the big salary they had offered him just to write a series of programs for them in the marketing area. Suddenly, you have a bad case of indigestion as the light dawns and you also remember all those program listings Joe took home while he was writing the marketing analysis program.

Sitting in your office mulling over the matter, you remember reading in *Computerworld* about some company out West involved in several lawsuits about software and trade secrets a couple of years ago. Sounded expensive and like something to avoid. You had even thought about talking to the company's lawyers about it, but you had never had the time. Maybe you ought to go talk to the lawyers now and see if there is anything you can do about Joe and the program. But then again, maybe it will all work out. After all, protecting the company's proprietary information is the legal department's job, not yours.

Wake up! Fortunately, this was just a nightmare brought on by those long hours at the office. None of this will happen if you just read on and then go back to the office on Monday and start implementing some of the suggestions in this article. You can lock the barn door before the horses (substitute "programmers") leave, but it's you — not the company lawyers — who have to take the steps to protect the valuable work your department does for the company. The lawyers can give you some good ideas to start, but only you can take the necessary steps before it is too late.

Lest you think this kind of thing doesn't happen, ask your lawyer about the trade-secret cases in the data base management field, or consider the value of some original microcomputer software like the CP/M operating system or Visicalc. Consider, too, the value of data like customer lists, demographic studies or just day-to-day accounting or engineering programs in every industry. One Texas software company, for example, just raised $7,500,000 in a public stock offering, based largely on some Apple II accounting programs originally written for a small grocery chain.

What Is a Trade Secret?

Before we discuss how to protect trade secrets and software, let's agree upon what a trade secret is. Most people seem to think it has to be secret, like the stuff the Pentagon has. That's just not the case.

While the law differs from state to state, there is substantial agreement that the definition in the California statute is a good one. It says:

"'Trade secret' means the whole or any portion or phase of any scientific or technical information, design, process, procedure, formula or improvement which is secret and is not generally available to the public and which gives one who uses it an advantage over competitors who do not know of or use the trade secret; and a trade secret shall be presumed to be secret when the owner thereof takes measures to prevent it from becoming available to persons other than those selected by the owner to have access thereto for limited purposes." (*California Penal Code §499c*)

This definition is good enough that a number of bad guys in California have been put in jail for taking or selling their employer's trade secrets in the form of hardware designs. It unquestionably includes computer

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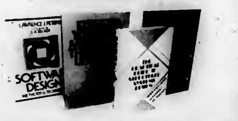

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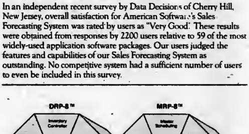
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programs, although I don't know of any criminal cases yet on this subject.

Lawyers have trouble explaining things in English, but in this case, it is clear that a trade secret is any information that you have that most others don't, if it is potentially valuable to another (usually a competitor) and if you take reasonable steps to prevent others from using it without your permission. Such a simple definition, but everybody makes protection of trade secrets out to be such a complex problem. Let's try to apply this law and see what you can do to prevent the nightmare described above.

Application to Software?

Simple. Any computer program that meets the above definition is clearly capable of being treated as a trade secret and protected by both civil and criminal laws of most states. The problem is that you as the DP manager have to see that the necessary steps are taken to keep your program a trade secret, and you can't always know which (if any) of the programs in your shop are going to be valuable.

So what can you do? Simple again. Take a few minutes now and set up some rules for dealing with your software in-house as trade secrets. Then, when the vice-president of marketing — or anybody else in the company — decides after the fact that it is valuable; you will have done all you can. Also, some programs are obviously more valuable than others and deserve more care than do the five-page quick and dirty ones that solve a one-time problem.

Before some clever person says, "What about copyright law — doesn't that protect programs?" let us hasten to add a comment or two. Since 1978, the new federal copyright law has, with some confusion, protected software. However, a number of steps must be taken to perfect that protection, and one of these is filing the program with the Copyright Office. Most people don't do that because of the time involved.

The other problem is the Copyright Office would like you to file the source code, which means people can and do have the opportunity to read the program and work out the logic. I don't think you need do this with day-to-day computer software if you treat it as a trade secret and take the first step toward claiming copyright of an "unpublished work." Copyright law is a subject beyond the scope of this article, and I leave it to another day.

But back to how software can be treated as a trade secret. The elements of a trade secret are:

- Information not generally available.
- Commercial value to someone else.
- Efforts at protection from disclosure.

What then do you do to make it a trade secret and what good does that do?

1. Clearly establish that you have proprietary information in the form of trade-secret software by advising new and existing employees that your company considers its programs valuable trade secrets not to be disclosed to people outside the company. Require programmers to sign confidential nondisclosure agreements that say they are not to disclose or take the software outside the company without written permission. Enforce this rule. Such agreements may not be fully effective with existing employees for complex legal reasons, but you would be foolish not to try.

2. Mark source listing "XYZ Co. Confidential — Not to be removed from DP Center." Be sure this marking is in the form of internal comments or remarks every 10 pages or so, if not on every page as a header or footer. Put the notice in the source.

3. For programs or data that clearly have some commercial or competitive value, consider numbering copies of source listings and signing them out on a log if they have to be removed from the company premises. Lock up all copies when not in use, especially at night. Alternatively, don't let programmers take listings home.

4. If the program is really valuable, consider having only a small group work on it and make clear it is not to be discussed with others. Require that all work be done and listings kept in a secure area where visitors are not allowed.

5. Do not leave machine-readable source on computer systems available to the company in general, unless locked with passwords or encoded. Do not leave disk packs or diskettes lying around if the programs have value.

6. Have old source listings shredded or burned just like confidential accounting data. Do not just toss them out or recycle them into memo pads.

7. Whenever possible, remind employees of the value of trade secrets and identify those things you are especially concerned about. When employees leave, conduct exit interviews and ask them if they have any trade secrets or confidential information. Require that they sign a statement that they have returned all listings and trade-secret information before leaving and that they recognize their obligation not to disclose information about programs on which they worked.

in short, take reasonable steps to see that the programs you consider confidential and valuable are treated that way. If you don't do so, don't expect the courts and lawyers to protect it after the fact. in our example, when Joe was allowed to take listings of a key program home without any controls or to discuss the detailed nature of his work with people outside the company, all trade secret protection was probably lost. If you knew he was leaving to develop similar programs for others, you should have acted then and discussed it with him.

Special Problems

The one problem with relying on trade secrecy as the sole method of protection for software is that it doesn't always work. Once a trade secret is disclosed without controls or limits on it, the protection may be lost. It is a little like the old saw about being a little bit pregnant — either you are or you aren't. Either the information (software, data or what have you) is not generally available, or it is because someone breached the security.

There is one thing you can do to help deal with loss of secrecy — add additional legends to the source and even object code (in Ascii literals) at the beginning and end of the code. Such a notice might read:

" Notice: This program is a proprietary trade secret of XYZ Co. and is not to be removed from company premises nor disclosed to anyone without a need to know. XYZ Co. also claims a copyright for this program as an unregistered and unpublished work under 11 USC §104 of the U.S. Copyright Act of 1976."

In this case, if you lose the trade secret protection you may be able to register the program with the Copyright Office later and thus gain protection under the copyright laws. A copyright will prevent literal copying, but not misappropriation of the ideas. It can be valuable if you can prove infringement (copying).

You should know, however, that lawyers — who like to argue about things like this — are not absolutely certain you can claim trade secrecy and copyright on the same item. Some lawyers therefore suggest that you should not put a regular copyright notice on the source.

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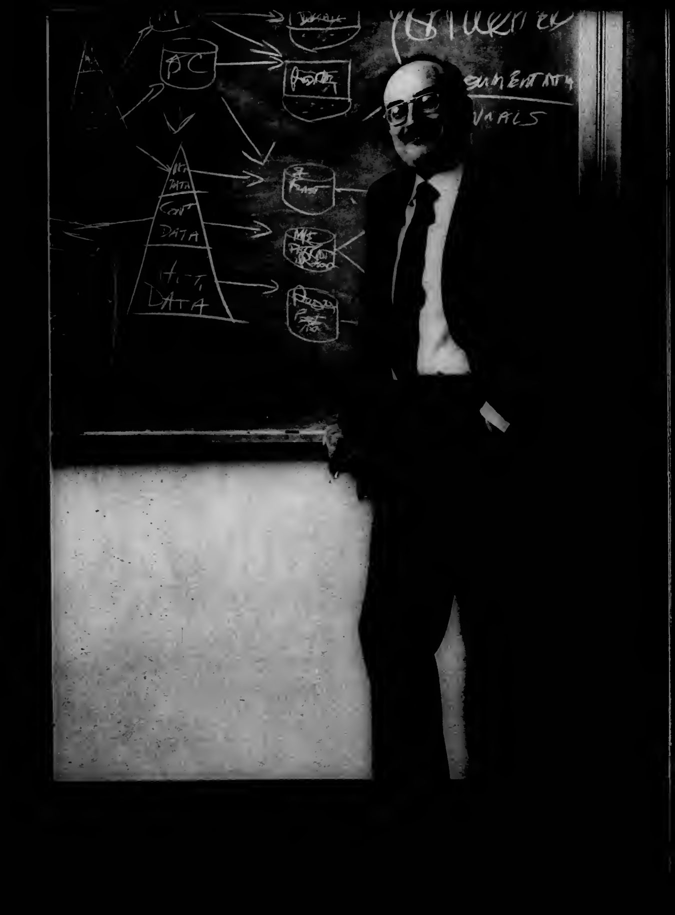
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Currently, there are several cases pending in the appellate courts which argue this issue. The Wisconsin Court of Appeals, in *M. Bryce & Assoc. v. Arthur Young & Co.* recently decided trade secrecy and copyright are not incompatible. I believe the other cases will eventually reach this conclusion. Trade secrecy depends largely on state law, while copyrights are now based only on federal statutes.

What Else Can You Do?

If you or your company decide to license the use of the software to third parties, it is important that this be done by a carefully written license agreement that restricts the licensee's use to specified conditions. The licensee should expressly agree not to disclose, copy or further license the use or possession of the software without your company's consent.

Surprisingly, there are many cases upholding trade secrecy where hundreds, if not thousands, of licensees existed. The issue is not the number of licensees, but the restrictions imposed on the users and the control exercised over the information. Based on this, the final protective step is to enforce agreements concerning trade secrecy and license provisions against licensees. If it can be shown that your company permits employees to violate their confidential agreements or that no effort is made to terminate licensees that do not follow the rules, the courts will not protect your programs. You may just have to bring suit against a licensee or fire a programmer who willfully and persistently violates company rules about trade secrecy. Again, only you as the management of the DP department can initiate and control these things, through a few common-sense rules and procedures.

In aggravated cases where the software is literally stolen or taken in whole or in part to competitors or commercial enterprises, there may be criminal sanctions such as California's Penal Code §499c cited above. However, since district attorneys and judges do not readily understand the value of software, it is incumbent on you to show that you and your company thought it was valuable enough to take regular steps to protect it. Again, if you didn't, the court won't. A recent California case decided a trade secrecy claim against the employer on exactly this factual point. You will need to have copies of nondisclosure agreements, confidentiality notices, sign-out logs and licenses with third parties if you have to go to court. Your lawyer can try the case, but you provide the evidence.

Civil Cases

There are a number of civil cases where courts have enjoined other companies from using trade secrets as well as awarding damages. This is especially so where there is evidence of hiring away employees with special knowledge at excessive salaries. There were elements of this in the Telex v. IBM case, on the part of Telex.

In our example with Joe, if you were paying him $40,000 a year and his new employer offered him $100,000 a year to do the same job, I think there would be a strong case for improper activity by the new employer — especially if it were going into the same market as your company.

Running through all this, however, is always the requirement that the information have commercial value and that genuine efforts have been made to restrict disclosure. Interestingly enough, perfection or even Herculean efforts are not required, just reasonable efforts, taking into consideration the relative values and costs. Thus, a massive data base management project might require great effort by the owner, yet a small but valuable microcomputer program might require only a showing that you locked it up at night and marked it confidential.

Conclusion

Every DP shop or programming effort should take advantage of trade secrecy protection, which essentially costs little or nothing. Once the steps are established, they become habitual, like walking or driving. The same steps protect all programs in your environment, and those with obvious value can be given special attention. But do ask your lawyer or legal department for help with agreements and licenses. After all, if they don't write programs, you shouldn't do legal work.

Davis, a senior member of the law firm of Schroeder & Davis, Monterey, Calif., has practiced business and tax law for the past 25 years. During the past 10 years he has specialized in computer law and business matters related to the computer industry, particularly software. He is writing a book on computer software protection and licensing expected to be released in 1983.

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THE USER WAVE
IN INFORMATION ENGINEERING

The application development backlog is overwhelming in many organizations. DP departments may be lagging three to four years behind in implementing user requests for new applications. In frustration, users are bypassing DP, installing their own microcomputers or turning to outside service vendors that offer high-level end-user languages in a time-sharing environment. These alternatives offer immediate benefits in rapid development of applications, but the benefits are often short term. The resulting multiple, incompatible, nonintegrated systems will bring long-term

By Clive Finkelstein

ILLUSTRATION BY ROBIN SPRINGUT

problems of cost and chaos that far outweigh their short-term benefits.

Some organizations are avoiding these problems, however, through a design partnership among users, management and DP. This is being achieved through information engineering — an integrated set of fourth-generation methodologies that extend from president to programmer, with spectacular results.

Information engineering originated in Australia and New Zealand. These methodologies have evolved from 1976-1982 into a combination of user-driven and DP-driven methods that draw on the experience and unique knowledge of users, management and DP. They were introduced to the U.S. and Canada in 1981 and are described in *Information Engineering*, by James Martin and Clive Finkelstein, (Savant, 1981). Figure 1 illustrates the major information engineering methods.

The user-driven methods include formal strategic planning techniques, which may start with a corporate focus, not just a systems focus as with business systems planning (BSP). These apply to all management levels throughout an organization and enable a precise establishment and evaluation of strategic alternatives to be defined by management.

Strategic Planning

The information engineering strategic planning methods are highly business-oriented, limited only by the scope of the planning activity — either corporate or, instead, directed at a particular business area function. They are based on formal management theory and result in expression of strategic alternatives. They produce logical models that represent prototypes of the organization and precisely identify the business policy and controls essential for success. They are directly developed by managers and users while they establish and refine strategic directions.

Distinct from traditional strategic planning techniques, which have an evaluation feedback cycle of three to five years, these methods provide progressive feedback after only weeks. A typical strategic planning project may take four to six months elapsed time, with two to five person-years of effort. However, unlike traditional strategic planning, these projects concurrently produce detailed specifications of the systems (manual or automated) needed to support the plans. These are represented in logical data models and procedure models.

Information Analysis

The logical data models are developed through the user-driven method of information analysis. Figure 2 illustrates a strategic current assets data model developed by senior management. (The derivation of this strategic data model is discussed in *Competitive Management Advantage through a Corporate Information Architecture* by Jeff Egglestone, Information Methods, 1982.) Figure 3 illustrates lower level purchasing and order entry data models developed by middle and operational management and users. These data models indicate the underlying data that drives the strategic data model in Figure 2.

These data models express management policy and controls in the relationships (associations) between data entities (data to be stored for later reference, represented by boxes in Figure 2 and Figure 3). These relationships define the conditions and logic for processing that data. The logical data models are expressed in third normal form and can be physically implemented by DP using any of today's conventional or relational data base management systems (DBMS) products (or conventional files), centralized or distributed. A typical data model for an entire organization may comprise 100 to 200 data entities, with perhaps 1,200 to 2,000 data attributes (data elements) across many functional areas.

Normalization by Users

Normalization of these data models (to third normal form or, if appropriate, to fourth normal form) is carried out by the managers and users themselves. They do not share DP's view that normalization is difficult; to them, it is common sense:

- "Why would you ever want to mix customer, order and product details together? They should be kept separate" (third normal form).
- "Checking account data attributes must be kept separate from savings account attributes" (fourth normal form).

The problems of early computer performance, which forced DP to combine unre-

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- The fully active, In-Line Directory is the central brain of TIS and controls every aspect of data access, security, integrity and application development. No access to the TIS data base is possible without the Directory's involvement. All "metadata" (data about data) is stored once to provide complete central control for the entire system.
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- The DBMS facility features hybrid relational data structures and virtual data base processing—with up to 95% of

lated data in the same file (unnormalized), are unknown to them: "You mean DP did not use normalization?"

Users and management can normalize much faster than DP because they understand the data and the business, and they can provide data meaning as expressed in relationships. Groups of users from different functional areas together identify and resolve synonyms (different names for the same data) and homonyms (same name for different data).

As users have carried out information analysis and normalization themselves, some dramatic results have emerged:

- In conjunction with procedure formation (discussed below), a precise requirements specification results. Instead of the voluminous, narrative document traditionally produced (and then used as input to analysis and design), a much more exact specification is produced in one-quarter to one-half the time.
- Information analysis and normalization highlight business alternatives and opportunities for feedback to management and refinement of strategic directions and objectives. Established strategic directions first provide the input to information analysis, which applies those directions and objectives in building the data model prototype. Their impact on the prototype can be assessed immediately for progressive refinement of strategies during implementation — rather than three to five years later in hindsight.
- The users define the data resource (to be managed by DP using a data dictionary) for implementation in the information center and for decision support system use.
- The user-developed third normal form data model completes a major proportion of the data base design task previously carried out wholly by DP.
- A clear understanding of data and requirements emerges. This is communicated in an unambiguous form through the data model not only to DP, but also to other users and to management.
- Common data across functional areas can be identified readily even if known by different names (synonyms) for data consolidation and integration of separate functional area data models.
- The data conflicts that may result from sharing common data are resolved. Those parts of the organization that create or delete specific data own (or have prime responsibility for) that data. Those parts that retrieve or update that same data have only secondary responsibility.
- The data model is technology-independent. It can be implemented with or migrated to any DBMS products or conventional files and can accommodate future business change with minimum impact of data bases and programs.

Data Dictionaries, Design Dictionaries

There has been much emphasis on developing software to automate normalization. No software can replace the searching examination of the organization and its directions for the future, which comes from active user and management involvement in information analysis and normalization.

DP's role here is more passive. (With the later DP-driven methods, they then take a major, active role). The data resource, identified by the users, is captured by DP in a data dictionary or in the now-emerging design dictionaries. These dictionaries have two major support roles: to provide a record of data definitions and to allow identification of what has been defined.

The latter design dictionary role can be extended into a central control dictionary for future systems. It indicates where data is used and tracks it through various design levels into physical — possibly distributed — data bases or files. It records all interrelationships of logical to physical data, procedures, events and objectives. It provides a repository for all common logic modules (defined through procedure formation below) for use as logic building blocks in future systems.

Software is essential here — to manage the data, to utilize it for design, to develop or modify data models, to drive the design of procedures, to generate data bases and to generate code.

When the essential business meaning of the data has been captured, with its policy and controls, we have the potential for computer-aided design of data bases and computer-aided manufacture of programs. This bypasses

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all data accesses satisfied in memory to deliver performance better than other DBMS systems.

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much of the traditional application development cycle and dramatically reduces the application backlog.

Procedure formation is another of the user-driven methods (see Figure 1) and follows information analysis. It uses the data model for design and development of procedures that process that data.

This reverses the traditional "procedure, then data" of systems analysis, structured analysis or BSP. The data is defined first and then, based on that data, the procedures are derived. We do not start with current systems; instead we start with the future as expressed by management objectives and then define migration paths from current systems to the required future systems.

Procedure formation results in the design of those future systems. It draws actively on the understanding of the business held by management and users. It does not depend on a knowledge of computers. It breaks processing down into business events, which add, delete, modify or retrieve data entities or attributes, and then combines those events into procedures designed directly to address the strategic objectives. A highly creative, lateral-thinking approach is used to progressively build a series of fundamental data change events into complex procedures. The policy and controls reflected in the data model define conditions that are used to link data change events into different procedural sequences.

These new procedures sometimes suggest new business opportunities. One organization established a strategic direction of large distributed warehouses throughout the country to achieve the corporate objectives of improved customer service and reduction of bad debts. Procedure formation suggested these objectives could be better achieved not by large distributed warehouses, but by customer self-service through hundreds of automated vending machines. The customer obtained immediate delivery of his order and, through prepayment, there were no bad debts. Procedure formation identified a new business opportunity management had not considered previously.

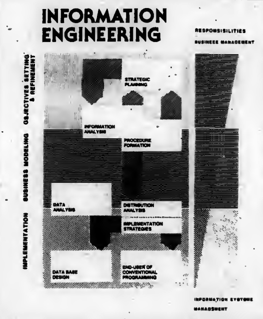

Figure 1. Methodologies Extending From President to Programmer

Through procedure formation, another organization identified nine procedures for receiving goods into inventory. They designed one standard procedure, with a dramatic reduction in purchasing department support staff and consequent application development. The existence of procedural redundancy in organizations is all too often overlooked.

Procedure formation uses logical procedure models to represent a graphical prototype of procedural logic. This is not like a data flow diagram: In an integrated data base environment, data does not flow. Rather, data is created, modified, deleted or accessed by business events. The lines joining events (ellipses) represent policy and conditions, not data flow. They implement the controls defined by the data model.

Procedure formation can be applied

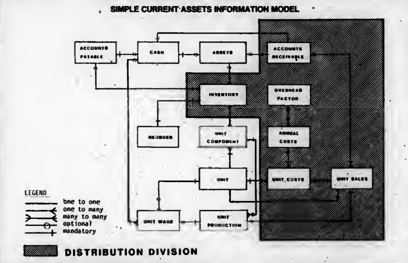

Figure 2. Strategic Current Assets Data Model Developed by Senior Management

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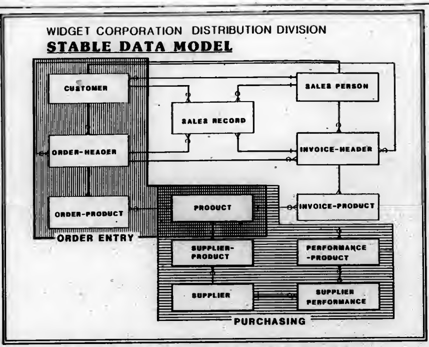

Figure 3. Purchasing and Order Entry Data Models Within Distribution Division

by analysts, but the greatest benefits are achieved when it is applied by users. This is described in *Procedure Formation: Design (and Specification) by Users,* Bob Rollason, Information Methods, 1982.

The procedure model is also called an event diagram and is a precise expression of procedural logic. It documents manual procedures or automated procedures. It can be expressed formally as narrative program specifications or as structured English specifications. Because of the intrinsic logic in the procedure model, the users themselves may develop the structured English for use in coding by programmers.

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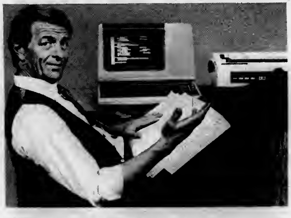

Procedure formation achieves logic cohesion as an automatic result.

Alternatively, the procedure model can be translated directly from its graphical form into a high-level end-user language (such as Focus, Ramis or Nomad) by the user. This may be appropriate for low-volume procedures. A programmer may instead translate the procedure model directly into Cobol, PL/I or Pascal for high-volume production procedures.

Each event in the procedure model can represent a separate program module. The procedure model is somewhat analogous to a structure chart. Each event exhibits high functional cohesiveness and, in fact, high data cohesiveness as well — a level of cohesion better than achieved with structured design. However, distinct from structured design, where achievement of high functional cohesiveness and low module coupling are dependent on the skill and experience of the structured designer, procedure formation achieves logic cohesion as an automatic result.

Procedure Formation Results

The results achieved by procedure formation are as impressive as with information analysis:

- A precise specification of requirements and feasibility emerges from this active user involvement in analysis and design. While producing concise requirements specification documentation much faster than traditional narrative requirements specification approaches, the users also complete a large part of the initial analysis and design themselves.
- New or improved procedures or business opportunities are identified. These emerge not by DP analysts interviewing users based on current systems, but rather by users and management (in conjunction with DP) first addressing strategic directions and objectives. They derive possible strategic alternatives or refinements and define potential migration paths from current systems. Quantified benefits and costs are developed for feasibility evaluation of identified alternatives.
- Immediate feedback is provided to management. The original strategic directions, together with identified strategic alternatives and migration paths from current systems, permit an evaluation and refinement of established strategies. Coupled with quantified benefits and costs of the alternatives, an assessment of organizational impact can be made by management.
- New organizational structures may thus be defined. The way in which an organization needs to structure itself to take full advantage of integrated data bases and new hardware and communications technology may need to be quite different from its structure with redundant application data bases and slow communication throughout the organization.
- Users become actively involved in the logical design of data bases and processing for the information center and can directly implement their most pressing applications themselves. The more complex systems are left for the greater expertise of DP. This lifts much of the application backlog from the shoulders of DP.
- Users may translate procedure models directly into high-level, end-user languages such as Focus, Ramis, Nomad or others. This may be utilized for low-volume decision support procedures, while high-volume production programs would be translated by DP, as described below.
- The precise representation of conditional logic in user-developed procedure models leads directly to structured code. Program specifications can be documented in structured English for input to structured coding. Alternatively, programmers can translate the procedure models (event diagrams) directly into structured Cobol, PL/I, Pascal or other languages.
- A library of common modules is developed through procedure formation. These common modules are easily identified and can be coded, tested and documented only once. They can be incorporated in programs (procedures) at compile time, linkage edit time or during execution.
- The problem of transition from structured analysis to structured design disappears. The users apply information analysis to define the data resource in terms of the business and its needs for the future. They design integrated data bases. They apply procedure formation to design integrated procedures for processing that data.

Information analysis and procedure formation identify strategic alternatives. They define integrated data bases with their integrated procedures. They provide essential feedback to management only weeks after the start of a project, rather than years after cutover, in hindsight.

DP-Driven Methods

So far, I have concentrated on the user-driven methods of information engineering, highlighting the bene-

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fits that result from more active user and management involvement in analysis and design. But where are the advantages to DP? How does DP function in this new environment? Does it signal the end of DP as we know it today?

The answer to this latter question is categorically "Yes!" Unless the DP department changes to be more responsive to users' changing needs, it will not survive! The users will go elsewhere.

Throughout the first half of the 1980s, we will see a transition from the traditional role of DP in the '60s and '70s to a new role: that of a specialist service organization.

The automobile industry evolved from an industry in the 1900s in which the driver was a specially trained chauffeur with an intimate knowledge of the car, to its present state in which the driver does not have to understand the car's technical workings. The driver (user) is now independent of the technician and can make his own decisions regarding usage. But he has specialist technical support to assist him if he needs help.

In the '60s and '70s, we custom-built programs. We saw the benefits of mass production, and our early application packages were like the Model T with limited options. You could have any color so long as it was black! The DP industry is the only industry in which we do not first build a prototype — or if we do, we call it the initial version. The housing industry would never allow us to define the addition of a roof as maintenance!

However, we now have the tools to develop prototype models. We have new DBMS products and high-level end-user languages. We can now implement in days what formerly took us months. And if it is not quite what is needed, we can change it rapidly — again and again.

Data bases and high-level languages are useless alone. Without the user's essential business knowledge and understanding, little can be achieved. The information center recognizes this and creates an environment whereby DP provides these tools and specialist technical support to the user.

This is part of the change needed; the other part is active participation by users and management in analysis and design. Unless appropriate data required by the users is implemented in the data bases, they cannot utilize it in the information center. Some of that data may exist in present production DP application systems. Some may have never existed previously in any DP system because it was never needed before.

The identification of this fundamental data cannot be based solely on current systems. It must be based on directions established by management for the future. Our current systems may reflect strategies and objectives appropriate for the past, but not applicable to the future.

Information analysis and procedure formation enable users and management to define data and processing needed for the future. DP can relate this to the current systems and define migration paths to required future systems.

The logical data models and procedure models developed by users provide concise documentation of requirements. In conjunction with an organization impact assessment by management of strategic alternatives, they provide input to DP for establishment of implementation strategies.

Implementation Strategies

This is a DP-driven information engineering methodology. It is concerned with planning the transition from a logical specification of data and procedures into installed physical systems.

The logical data models and procedure models are technology-independent:

- They enable DP to determine the optimum location of data and processing — either centralized or distributed. Distribution analysis (see Figure 1) enables communication network designs and trade-offs to be established.
- The local data models permit exact selection of the most appropriate DBMS products for implementation, whether hierarchical, network, Codasyl, inverted or relational — either centralized or distributed:
- The data model and procedure model provide a precise definition of requirements for selection of application packages. A data model for each application package can be developed easily by DP (through data analysis). Are essential entities and relationships supported by the package? Can it be changed to support them, or must the business change? Can it? What is the cost of package modification? What is the cost of the business change? How does that relate to the benefits? For example, a manufacturer found no available

(Continued on Page 74)

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Integrated Fourth-Generation Software Languages

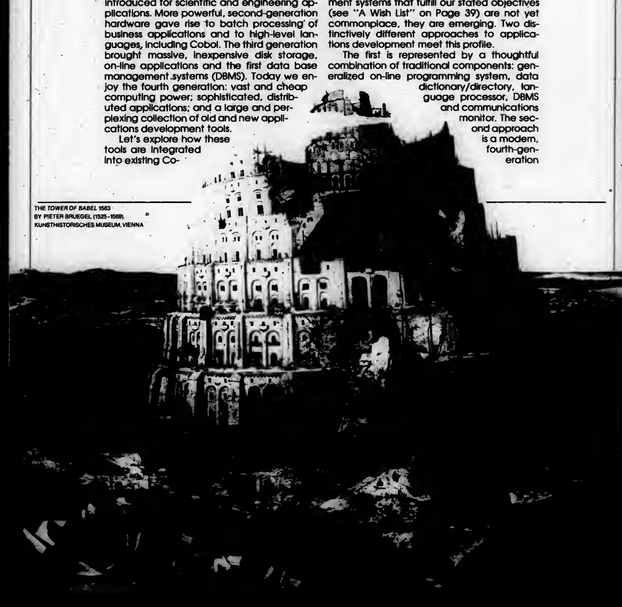
By Richard L. Kaufmann, Martin A. Goetz and N. Adam Rin

Inexpensive computing power has, over time, given rise to new applications and to new tools and methods for their effective implementation. First-generation computers were introduced for scientific and engineering applications. More powerful, second-generation hardware gave rise to batch processing of business applications and to high-level languages, including Cobol. The third generation brought massive, inexpensive disk storage, on-line applications and the first data base management systems (DBMS). Today we enjoy the fourth generation: vast and cheap computing power; sophisticated, distributed applications; and a large and perplexing collection of old and new applications development tools.

Let's explore how these tools are integrated into existing Cobol or PL/I environments and how they can be extended throughout an organization for control of DP activities.

While integrated applications development systems that fulfill our stated objectives (see "A Wish List" on Page 39) are not yet commonplace, they are emerging. Two distinctively different approaches to applications development meet this profile.

The first is represented by a thoughtful combination of traditional components: generalized on-line programming system, data dictionary/directory, language processor, DBMS and communications monitor. The second approach is a modern, fourth-generation



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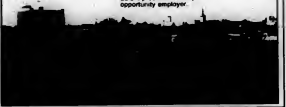

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Tower of Babel Effect

Investment in Cobol programs is so great that it is difficult to turn our attention to more modern alternatives. The same is true of Cobol programmers, who continue to emerge from industry and government training programs in surprising numbers. Cobol, whatever its failings, is not yet dead.

Cobol and its contemporaries, however, address only a portion of today's programming language issue and provide even less of the solution to the total applications development problem. This is evident in most organizations committed to the development of progressive, on-line applications using data base management software and methodology. A partial examination of the software tools used to build the modern DP application will reveal a diverse product mix and a broad collection of supporting skills, such as:

- Cobol language (or PL/I, Assembler or other generalized language) is used for programming the complex aspects of an application and often binds the entire application together by such means as CALL-level interfaces and report file extraction.
- Various data base management systems (DBMS) are often found, each with its own architecture, physical interface requirements and navigation rules. Some organizations support several DBMS packages at the same time.
- Data communications monitor packages are necessary for on-line applications and often require that applications programmers understand the specifics of transaction, memory and task management.
- Precompilers, such as IBM's Command-Level CICS, are often used to soften the interface details between the programming language and the DBMS and communications monitor.
- Report generation has been handled outside the formal languages area. For years, programmers and end users have been using Easytrieve, Mark IV, DYL 260, Datareporter and other nonprocedural report definition packages to generate reports quickly and easily. In large DP organizations, only common applications are developed using several report generator packages, each supported and maintained by a few people in a corner of the organization.
- On-line panel definition, dialogue management and transaction processing are handled by various packages and utilities, sometimes dependent upon the particular communications monitor in use. One such package is frequently used to prototype an application while another is used for the actual implementation.
- Data dictionary/directory systems are used primarily for passive data definition. Generally, some sort of output utility is invoked to define the data base and to generate record descriptions for language interface in the form of COPY library members.
- Interpretive query languages are used by the application's end users to handle effectively simple ad hoc requests for information from a DBMS.

This list includes only those applications development tools required to build or program the application, but it demonstrates that modern applications development remains complicated, promising few significant productivity gains. Further, considering the diversity of packages required, management risks losing control through a Tower of Babel effect, where development staff skills are so dispersed that meaningful communication and maintenance responsiveness are affected.

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applications development system and support environment that attempts to integrate fully all services in the most optimal and user-friendly manner.

These alternatives have great merit and represent the direction of applications development systems for the 1980s and beyond.

Integrating Traditional Tools

The approach to integrating traditional tools for applications development combines on-line and batch components in several software layers.

Most apparent to the programmer is the layer supporting the interactive workstation for programming, which is based upon a generalized on-line system such as IBM's TSO or Applied Data Research, Inc.'s (ADR) Roscoe. In addition to their normal full-screen text editor and commands for utility functions, such systems typically feature interpretive command languages that can be used to build specialized applications.

In support of program development, menus and prompters often are implemented to develop the nucleus of a program, to select data definitions and to provide on-line help. Extended commands are added to generate large blocks of formatted code from simple shorthand notation.

Automatic job stream generation permits convenient disposition of the resulting source program by invoking the batch translation and compilation processes.

If the data dictionary/directory is integrated in the on-line layer, logical data base definitions can be displayed on-line for reference during program development. In brief, the on-line layer provides many convenient services to the applications developer working at a remote terminal and automates cumbersome tasks such as job stream and program nucleus construction.

Following development of a program in such an interactive environment, the source program is secured and submitted for compilation in

(Continued on Page 42)

A Wish List

Alternative application development approaches that can result in meaningful improvements in productivity must recognize that data definition, application structure, data base access, transaction processing, report definition, panel definition and so on are convergent disciplines that comprise the bulk of modern business applications software. The software tools must be integrated so development in one discipline has a beneficial effect upon others. The profile of an integrated applications development system that fulfills this concept can be summarized as follows:

- An integrated, active data dictionary is essential to the effective management and control of the organization's data resources and the applications development process. It is the data administrator's principal tool for defining and controlling the organization's data resources.

The central role of the data dictionary requires that it drive and control the data base management system, the application programming facility, the query language and report generators by a common model and interface. It provides for data definition that is common to the data base sublanguage, application logic, report and transaction definition and so on. Extended to model the relationships between other entities, such as systems, programs, users and logical views of the data base, the dictionary can also be used to document, control and manage the resources of the development project and the production environment.

- The functional programming language and facilities should contain all the statements for data handling and arithmetic found in traditional business languages, plus effective sublanguages for data base management, communications control and report generation.

With respect to these data base, communications and reporting sublanguages, the language should be as nonprocedural as practical, permitting declaration of common logical tasks in lieu of explicit procedural programming. Logical data base definitions are extracted directly from the active data dictionary during language translation. Panel definition and report declaration should be fully integrated with the communications and reporting sublanguages.

In brief, the functional language addresses the entire spectrum of modern business processing applications.

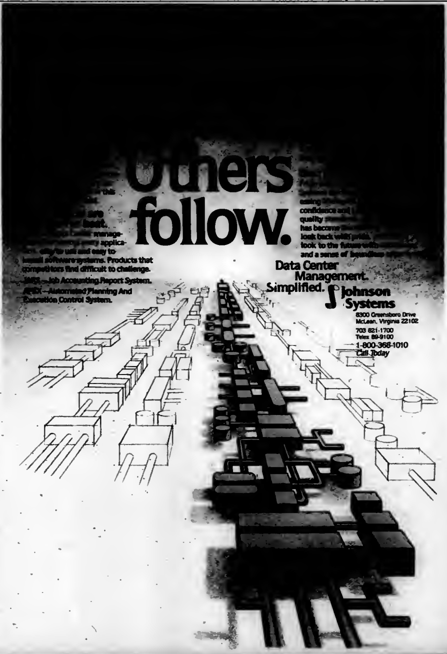
- The programming language should be organized consistent with the design and development methodologies that have emerged within the last decade. It should support top-down development, featuring local subroutines and innovation of subprograms with explicit control over passed parameters. It also should support control structures for selection and looping that are clearly delimited and can be freely nested.

- The development support environment, including libraries, utilities and so on, should be available to the applications developer in an interactive, workstation environment. A good general-purpose on-line programming system, complete with full-screen editors, remote job entry services, an effective command structure and output browsing facilities, provides an excellent foundation. An even more effective technology is the specialized, integrated support environment that is sensitive to the specific development process. In addition to the capabilities of the generalized system, the specialized support environment can include menus, on-line help, extended commands, language-sensitive editors and on-line language translation and execution..

In addition, the support

(Continued on Page 42)

Software tools must be integrated so that development benefits all.



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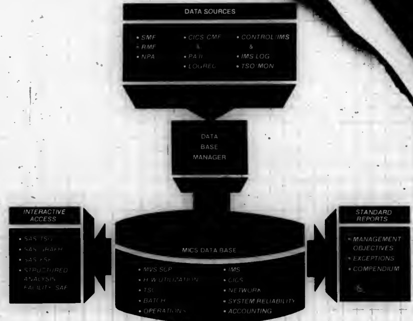

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(Continued from Page 38)

batch. The program is often more modern in terms of structure, data base sublanguage and on-line transaction management than conventional Cobol or PL/I, although the primary orientation of the language may be to Cobol or PL/1 syntax. With Cobol, the higher level language might include in-line looping and multiway selection constructs that are not yet available in Cobol.

Another example is the command-level CICS language, which provides for on-line transaction, task and memory management using syntax that is more easily understood and maintained than cryptic CALL-level interfaces. The first batch steps during the compilation process, therefore, are precompilations to translate the higher level source code to conventional language acceptable to a standard compiler.

The multipurpose precompiler, a macro processor such as ADR's Metacobol or the embedded PL/I preprocessor, is especially useful during this batch precompilation stage. As with on-line interpretive command languages, macro processors are very flexible. For example, they can be programmed to accomplish more than one task during a single translation or to support an unusual configuration of data base management system and communications monitor. As a basic integration tool, a macro processor can extend Cobol, for example, to include modern logical structures and Cobol-like statements for data base and communications interface. With an active interface to the data dictionary/directory, the multipurpose precompiler can further include dictionary-defined logical data base definitions, shield the programmer from unnecessary knowledge of data base internals, check authorization, diagnose errors in data and language usage and post status to the dictionary's resource model. In brief, the multipurpose precompiler can modernize and extend the underlying standard language, thereby providing better applications development leverage to the programmer trained and skilled in using that language base.

The logical terminal screens or panels that are a part of on-line applications are generally not a part of the source program. Typically, they are developed using a separate utility. More advanced products are emerging which permit painting the panel on a blank screen followed by interactive definition of field names, attributes and editing rules. In this process of Integrating traditional software tools, however, panel definitions are not coupled to the programs that use them until the program is executed.

The subsequent batch layers in the integrated but traditional applications development process are conventional compilation and linkage editing of the standard generated Cobol or PL/1 program. While the underlying safety net of a standard language may be a requirement of an organization (or simply comforting), there is little expectation that debugging or maintenance can be carried out effectively at the generated code level. The intermediate Cobol or PL/1 code is simply a higher, more portable form of object code. Development, testing, debugging and maintenance must be conducted at the higher extended language level in order to reap the full benefit of this approach.

In conclusion, it is a major step forward to integrate traditional development tools by extending the standard language, coupling it to a data dictionary/directory and DBMS and supporting the development process in an interactive environment. The standard language orientation provides an underlying safety net for

A Wish List

(Continued from Page 39)

environment should be integrated with the active data dictionary to check user authorization, permit on-line viewing of the logical data base definition and automatically update the control and status information in the resource model of the data dictionary/directory.

This wish list of integrated applications development tools and services is largely complete and serves to collect diverse development tasks under an interactive and integrated umbrella where they can be effectively managed and controlled. Integration also minimizes the redundancy of tasks associated with diversity of components and thereby minimizes the skills inventory necessary within the development team. For example, in the diverse environment, there often is separate definition of the logical data base for the application programs, query languages and report generators, even when a data dictionary is available.

The integrated environment, on the other hand, requires only a single definition of the logical data base.

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the organization committed to industry standards and represents an easy transition for programmers already skilled in the base language. Equally important, the approach remains consistent with purchased applications that are delivered in conventional Cobol or PL/1 form.

Finally, it should be recognized that most integration is delivered by a vendor in support of a specific software product line. For the organization committed to a mixture of software components, the robust nature of macro processors and interactive command languages may be the only glue available to bind the sum into an effective whole.

Word of Warning

There also are limitations to such a traditional approach. Where each layer of software accomplishes a portion of the applications definition process, flaws uncovered at one level often require backward tracing and correction at a higher one. The integration of traditional development tools represents a manageable approach that can lead to new levels of productivity, but is not so complete or ambitious an approach as the fourth-generation applications development systems described below.

Fourth-Generation Systems

An alternative to the hodgepodge approach and to integrating traditional tools for applications development is the so-called fourth-generation applications development system. A dozen or more products that address part or all of the wish list described earlier have been introduced since 1980; they represent a significant departure from the traditional languages and methods for applications development.

Typically, these applications development systems are entirely new and attempt to integrate more fully all development services in the most optimal and user-friendly manner. Some, like IBM's SQL/DS, ADR's Ideal, Cincom Systems, Inc.'s Mantis, Cullinane Database Systems, Inc.'s ADS Online and Software AG's Natural, are associated with a vendor's particular data base product line.

Others, including Information Builders, Inc.'s Focus and Mathematica, Inc.'s Ramis II, are independent and support interfaces to several DBMS. All have been directed toward end-user involvement in the applications development process, order-of-magnitude productivity gains and capability that spans the entire spectrum of modern applications development.

At their best, fourth-generation applications development systems boast a sophisticated on-line support environment or workstation that provides:

- Menus and help services to coach the inexperienced user.
- An efficient command language for the experienced developer.
- Language-sensitive editors that streamline the programming process.
- On-line compilation and execution services to speed development.
- A flexible printing capability that permits routing and on-line browsing of listings and reports.
- Integrated, active data dictionary/directory control and coordination.

To date, however, few of the available products support the full complement of these services.

Unlike the integration of traditional tools described previously, the fourth-generation workstation is not supported by a separate software layer used only for on-line program preparation. The on-line support environment is fully integrated with the programming language and other development services, the data dictionary/directory and program libraries, the data base, the communications monitor and the operating system. It supports the programming activity; controls checkout, compilation and testing of the applications; and constitutes the operation environment for both on-line and batch execution.

Truly fourth-generation applications development systems must be tightly coupled to a data dictionary/directory. The role of the integrated dictionary is to permit viewing of logical data base definitions during development and to include the current data definitions directly during program compilation.

Additional uses of the data dictionary during development are to check user authorization, to control and enforce an application's resource usage and to permit on-line inquiry of all entities and relationships defined in the dictionary. The dictionary can even be used just prior to execution of the application to determine authorization and to assure production status of all application modules and components.

Finally, since fourth-generation languages and other programming services are directed toward the most modern business applications, they are not encumbered by more traditional languages like Cobol. Where

Truly fourth generation applications development systems must be tightly coupled to a data dictionary/directory.

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practical, well-understood declarative tasks are defined by nonprocedural means. Examples of these applications development services include dictionary-defined data descriptions, interactive prompts for defining the central components of the program or application, panel painting and interactive fill-in-the-blanks report definition.

Typically, the logic portion of the language is consistent with modern design methods, language advances and data base theory. For example, the structure of true fourth-generation languages supports convenient top-down modularization and explicit, in-line control structures for selection, repetition and even data base management. Further, the data base management portion of the language often views the logical data base in relational terms, permitting set-at-a-time retrieval and updating of the logical data base with little or no knowledge of the physical data base structure and no need to program the navigation through that structure.

The fourth-generation applications development system is, in our opinion, a wholly modern system equal to the development challenges of the 1980s and beyond. It is integrated in the sense of a tightly coupled, controlled environment that is both easy to learn and use for new users and efficient and complete for the skilled professional. It brings end users closer to the development process through convenient prototyping of application externals such as reports and panels. These systems offer the potential of significant productivity gains through ease of use, the convenience of all development services at a terminal workstation, the completeness of modern language and the leverage provided by integrated facilities.

Fourth-generation systems should be carefully considered. Very few match all features of the profile we have described. To date, some are not supported by a data dictionary/directory and some can only access a special off-loaded data base. Some have language structures that are outdated or inadequate for the development and continued maintenance of complex business applications. Almost all are wholly independent from a language standard, requiring complete retraining of applications developers and leaving existing and purchased applications to be maintained in conventional Cobol or PL/1. Applications developed using fourth-generation systems are generally perceived to be slower, to require more computer resources and to be more difficult to tune. Finally, most fourth-generation applications development systems are positioned strategically within a vendor's data base product line and therefore commit the user to that vendor's data dictionary/directory, DBMS, support organization and financial stability.

While we encourage adoption of the progressive software tools we have described for effective and controlled applications development, we also suggest that selection of specific tools should be done carefully.

A Final Thought

We have touched upon some options available to organizations in developing computerized business applications. We have not discussed how these new systems might be received or accepted in the organization. Regardless, existing applications must be maintained and enhanced while these new fourth-generation software systems are introduced. Management must plan carefully when introducing new progressive systems. It must provide the necessary training and education and must establish the data dictionary and data base administration controls so crucial for the effective use of the integrated fourth-generation system software.

Tomorrow's tools are here today, and an organization must recognize their potential benefits. When organizations properly utilize these new tools, significant productivity benefits will result and the full potential of computers will finally be realized.

Kaufman is vice-president and group product manager at Applied Data Research, Inc. (ADR) and has worked with software for over 20 years. He is coauthor of **High-Level Cobol Programming** *with Gerald M. Weinberg, Martin A. Goetz and Stephen E. Wright.*

Goetz is senior vice-president and director of the software products division at ADR. He began his career with Sperry Rand as a programmer in 1954, and he holds the first U.S. software patent. He has written extensively on the software industry, and is a frequent contributor to Computerworld.

Rin is a product manager at ADR and holds a Ph.D. from the University of Pennsylvania. He has taught at the University of Michigan, written numerous papers and conducted research in languages, automated tools and methodologies for software development.

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Software for Micros in Distributed Environments

By John J. Tibbetts

If one were to attempt to list the major technological changes of the last decade, surely at the top of that list would be the so-called microcomputer revolution. Over the past 10 years, intelligent devices have migrated from the research laboratories into industry and then into small business and the home. The extent to which microcomputers have penetrated our society would have surprised the most adventurous futurist of 10 years ago, and this wave of change does not seem to be slowing down at all. Projections show very rapid growth over the next five years, both in home use and in business.

It seems ironic, however, that the last domain to benefit from the microcomputer revolution is the DP community: the users and managers of the minicomputer and mainframe ancestors of the micro. Of course, the impact of microelectronics within these larger computers and their devices is gratefully recognized. But where are the Apples and Zeniths in mainstream DP applications?

Even worse, the micro is not only not proving an ally to the DP manager, it is becoming a nuisance in some cases. The DP manager already has plenty to worry about. Order processing wants to convert its batch system to a distributed interactive system — by fiscal year-end. The management of the data entry function is becoming increasingly difficult as transaction loads increase. In addition, it's getting harder all the time to train interactive users in the ever more bewildering array of new and different terminals, each with its own slightly different user interface. And finally, the comptroller is nagging you again to "do some-

thing" about the flood of microcomputers now seeping, now pouring, into the organization at all levels. (When you jokingly remind him of his own new IBM Personal Computer for financial planning, he doesn't seem amused.)

Micro as Ally

Industry observers state that, for a variety of reasons, micros are already well on the path from being a nuisance to being an ally of DP. New and more powerful micro hardware appears daily. Very significant for the DPer, this hardware is coming from reputable companies, even from firms that supply DP's main computing resources. In a similar vein, the hardware can be maintained on-site without being carted off to the local computer store.

Software, however, is the main reason for optimism. The DP community has been justifiably skeptical about microcomputer software. After all, the clear and constant message of the past decade has been to clean up the process of developing software. Structured programming and design, walkthroughs, Hipos, high-level tools, data base management systems, standard languages and layered communications are all treatments for the ills of large software projects. Contrasting these developments with the first round of micro software — based on assembly language (or, at best, on Basic) sparsely documented, barely tested and never supported — the DP manager might well be concerned.

However, the micro software situation has changed rapidly. Professional-grade operating systems and high-level structured languages now exist which rival the development capabilities of the big machines. Of course, it takes more than tools to build quality software. Competitive pressures are forcing microcomputer software developers to produce software consistent in design, documentation and support with its mainframe counterparts.

Perhaps most promising to the DP manager is that class of software that can turn the various micros in the organization into smart terminals. This concept acknowledges the innate characteristics of the mainframe as the data base engine of the organization, and at the same time recognizes the superb characteristics of the micro for providing the user with a high-grade interface. If any one great application exists for the microcomputer, it is in the area of the human interface. One need only play a video game or operate Visicalc to gain an appreciation of the instantaneous response a micro can give its operator.

Not only does the micro respond more immediately than does a conventional terminal, it also can be far more intelligent. With local memory and disks, the micro can perform edits, store and display screen formats, look up local tables, reformat and print data and generally perform all the other functions associated with an intelligent terminal.

Users like the micro's multifunctional nature, which makes it a hidden DP resource. In fact, many probably already have, or have plans for, their own micros. Even though each unit may be different, a little planning allows DP software to use them all. With newer portable operating systems, one organizationwide user interface can be designed to run on all of the organization's micros, which minimizes the need to retrain people continually for new applications or to reprogram applications for new hardware. And the users still have their micros for their local needs.

In succeeding sections, we'll examine in more detail the characteristics of a microcomputer as both an off-line and an on-line terminal.

Off-Line Data Entry

Despite the sometimes misplaced emphasis on interactive applications, the majority of most computer applications are still executed in some kind of batch environment. An example is off-line data entry, the process whereby the data is first captured and then submitted for processing. The spectrum of off-line data entry is bounded by the following two extremes:

- Volume Data Entry: The data entry usually is done by professional keypunchers who enter batch after batch of data. The keypunchers are managed by the DP department, and emphasis is placed on keystroke rate. Errors in data, even if discovered, usually need to be turned back to the user department for correction.
- User Data Entry: The user department enters its own data. The entry operator may not be a trained keypuncher and may perform this function only part time. The emphasis is on accuracy and on getting transactions through the system, rather than on keystrokes alone.

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Choosing Micro Software

Adam Osborne, the microcomputer industry guru-cum-entrepreneur, has said for years that personal computer makers should avoid the pitfalls of the larger computer manufacturers — namely, developing proprietary operating systems and software. Apparently, some have heeded his advice: Digital Research, Inc.'s CP/M has emerged as the de facto standard industry operating system for 8-bit machines, as CP/M-86 is for 16-bit computers.

The microcomputer software market is expected to tip in et $700 million this year and to reach more than $5 billion by 1985 — most of it based on CP/M. Even so, Visicalc, introduced in 1979, remains the top seller: more than 300,000 copies have been sold. Visicalc was adapted to run on different computers; now, most manufacturers offer their machines with CP/M, since there is a large library of compatible software.

According to Bob Tepper and John Shagoury of Standard Software Co. in Randolph, Mass., CP/M-compatible software outsells all other business software. Standard Software, which sells mainly to the Fortune 3000, lists the top 10 best-sellers as:

1. Wordstar, e word processing program (Micropro International Corp.).
2. Supercalc, an electronic scratch pad/worksheet (Sorcim).
3. Dbase II, a relational data base management system (Ashton-Tate).
4. Datastar, for data entry and retrieval (Micropro International).
5. General Ledger (Peachtree Software, Inc.).
6. Accounts Receivable (Peachtree Software).
7. Calcstar, an electronic spreadsheet (Micropro International).
8. Spellguard, a proofreader/dictionary (Innovative Software Applications).
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10. Accounting Plus (Software Dimensions).

Infoworld, C.W. Communications/Inc.'a weekly newspaper for the microcomputer industry, regularly publishes unbiased reviews of business software packages, as well as the volume, "A Critic'a Guide to Microcomputer Software."

As the personal computer pervades corporate environments more and more, compatibility between computers of all sizes and descriptions becomes more problematic. The compatibillty CP/M as an operating system and as applications software provides could be the last hurdle in integrated computer systems.

dicated that almost 70% of them are shifting or planning to shift to user data entry.

The reasons for this trend seem numerous: more accurate data entry, demands from the user for more responsiveness, desire on DP'a part to get out of the data entry business and so on. In any case, both of these data entry profiles are relevant to the design of a micro-based data entry system.

It is important to note from the outset that a data entry system is not e file management system, although it is often mistaken for one during a demonstration. It has a fundamentally different set of performance, reliability and data integrity objectives from those of a file management system, and these differences will be identified as we cover them.

Building a comprehensive data entry system from the ground up is a large task. If each DP organization had to program its own, any possible cost savings of microcomputer data entry would be lost immediately.

The first step in building an epplication is specifying the screen formats (forms), which is accomplished by drawing a picture of the form on the screen itself. Various editing or processing attributes can then be associated with each data field, such as checking the type of the data; performing range checks or table lookups; and adjusting, filling, overpunching or upshifting data fields. Other field attributes can specify rekey verification, batch totals, default or duplicated values. In addition, an output specification can define the reformatting of data when it is finally submitted for processing.

The choice of a form-oriented approach to data entry tends to favor user data entry more than the conventional "virtual card" approach, in which entered data is simply built into a long line. The form can be built to look like the actual transaction document. Making corrections on the form is very similar to operating e formatted block-mode terminal, except editing is performed instantly. Volume data entry operators tend to need some adjustment to this approach if they are not used to it, but they adapt to it quickly. Subsequently, training new people coming into the department is easier than with the older systems.

Another area of adjustment for most volume operators is that of keyboards. Most micros support typewriter keyboards that are different from the conventional data entry keyboard with embedded numerics. In some cases, conversion to the typewriter keyboard is seen as desirable; in others it is tolerated. And in some cases, a micro must be selected (or the low-level keyboard software modified) to support the data entry keyboard.

Keystroke performance on a form varies greatly depending upon hardware implementation, particularly on the keyboard "type-ahead" (the ability to keep typing when the micro is otherwise busy). Although keystroke performance is not a problem for many user data entry stations, for volume data entry stations it can be quite important. On machines with full type-ahead (for example, the IBM Personal Computer), an operator can keep typing even if buffers are being written to the disk. Keystroke rates can be as high on these types of systems as on any buffered keypunch or customized key-to-disk systems. On machines without type-ahead or partial type-ahead (for example, Apple Computer, Inc.'s Apple II, which has type-ahead except during disk activity), the keystroke activity drops somewhat. Such systems, although they may be quite suitable for user data entry, may not be advisable for volume data entry.

Once created, forms can be combined in a variety of ways. This capability allows the designer to link many forms together into a multilayered structure much like the levels in a Cobol or PL/I record definition. Real-world data entry applications must be able to accommodate very flexible structures with repeating, optional or even dynamically varying forms. This requires much more structural flexibility than does a file management system.

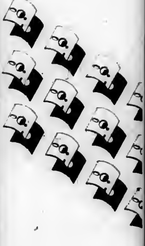
At this point, the application is complete. A data batch can be created and the entry process can begin. The data batch needs to be controlled by the data entry software. It should be monitored for current status (just opened, closed and ready for processing and already-released for processing). Special commands must be available to management to change and override this status. Certain overhead data may need to be kept with the batch, such as operator name, control card information and so on. Note that a batch differs from a data base; its average life span is about four hours. Consequently, keyed access to the data may not be so important as maximized flexibility of access and structure.

The actual data entry process includes many of the commands contained in a file management system: ADD, MODIFY, DELETE, LIST and SEARCH. However, other commands are different:

- VERIFY: Specifies the data (specified by field) needs to be reentered in a separate pass (and optionally by a different operator) to ensure the correctness of the data.
- TOTAL: Generates batch totals of specified fields — such as the amount field in a check register — to guarantee that the numbers were entered correctly.
- CORRECT: Searches for the next record in the batch that has an error in the data. But with extensive editing capabilties, how did an error get into the data? In volume data entry applications, the operator may often discover a data error that cannot be resolved et entry time. The data entry system should allow for the entry of that field anyway, but record that it is there. A batch with an error should not be able to be closed (without an override). CORRECT helps the operator find the errors left in the batch.
- CLOSE: Closes the batch to subsequent entry and checks that no remaining errors exist and also that verification has also been completed. The data is now ready for unloading.

The final stage in the data entry cycle is to move the data from the batch

Training new data entry people is easier on micros than with the older systems.



to the machine that actually needs the data. The actual communication process will be covered in a succeeding section.

The data entry capabilities described here may appear to exceed the capacity of a microcomputer, but new software products have all of them and more. When attention is paid to efficiency and performance, today's microcomputers can handle sophisticated tasks.

Other Alternatives

Other, more established, methods of performing data entry do exist. The advantages of using a microcomputer have already been outlined. It is time to compare the micro approach and some conventional methodologies:

- Compared with collecting data on cards or with a key-to-diskette machine such as the IBM 3741, the microcomputer can do a much more comprehensive job of editing data. Seeing the whole transaction on a form that looks like the source document raises the quality and can shorten the time of data entry. After all, the real data entry job is not to enter keystrokes, but to enter transactions. In addition, the micro, using a form, is much easier to use, especially by a non-keypunch user.
- Compared with an intelligent key-to-disk system, the micro is roughly equal in terms of key entry performance. It is also programmable and provides for very smart data collection algorithms. In fact, for volume data entry applications using professional keypunch people, micros can be faster because they can be programmed to look like the older keypunch technology. The principal advantage of the micro over the key-to-disk system, which is usually implemented by a minicomputer with a cluster of terminals, is that the per-station cost of the micro is considerably less until there are a large number of operators (about a dozen) in the same location. For operations with only a few stations, or in user mode operation, the micro is both less expensive and multifunctional.
- Compared with using an on-line terminal of the mainframe or mini, the per-terminal hardware cost is more expensive with a micro than with a dumb terminal. However, real costs may be quite different. The burden on-line data entry places on most large machines can be considerable, especially if extensive form painting and character mode edits are performed. In distributed applications, the communications cost of keeping terminals on-line may be considerably more than the cost of computer hardware itself.

Nevertheless, in certain applications where real-time data base edits are important, on-line communications remains the best solution. In terms of performance, the micro scores higher in both keystroke and operator performance because the microprocessor can devote itself to the fingertips of the operator.

Performing off-line data entry onto a micro would be a pointless task without a reliable communications environment. While not intended to be definitive, the following points should serve as guidelines to microcomputer communications capabilities.

Most microcomputer communications is based on asynchronous communications. If your mainframe or mini supports it, you have a point from which to start. Unfortunately, asynchronous standards define only the physical connection, not a standard data link protocol for a clean communications channel. Although a number of software packages that send and receive data files are available for micros, most do not support an error-checking protocol. You should select a software package that provides error checking. Select one that features blank compression, as well. For forms-oriented data, blank compression can reduce character traffic by as much as 50%.

An increasing number of micros, especially those from big-name manufacturers, are coming out with synchronous hardware and software such as 2780/3780 emulation for batch data or 3270-emulation for interactive data. If your mainframe supports these protocols, they are ideal for clean efficient transmission of data.

If you have only asynchronous on your micro and still need to talk synchronously, a number of protocol converter boxes are offered to perform the communications external to the micro. This approach has the extra advantage of not burdening the micro with the CPU-intensive work of handling a sophisticated protocol.

Beyond Off-Line Entry

This discussion of off-line data entry has ignored one significant point. There is a strong trend toward taking applications with a real-time requirement and putting them on-line. Although conventional data entry wisdom has no solution for this except to go out and buy an on-line terminal, the micro-based application can, with the appropriate additional software, switch the micros on-line. By means of the very same form definitions, data can now be entered on-line or off-line, depending on design, priority or preference. Here is a snapshot view of a few hybrid applications:

- An order entry system design calls for off-line data entry. However, there is one data field, customer credit limit, we would like checked in an on-line data base. From within the data entry form, a lookup request is emitted to the remote computer while the operator continues to fill in the form off-line. When a response is available, the operator can proceed or correct as required.
- On the same application, we would like to enter the data off-line and go on-line and dump the data right into the transaction processor. Any data base error identified on incoming transactions can be fixed on-line using the very same form (and operator conventions) used when the transaction was first entered off-line.
- Occasionally, we would like to allow the operator the option of entering a priority order directly on-line without waiting for a batch to be completed. Again, the operator uses the same workstation and procedures to enter the order, but this time it enters the system immediately. In fact, with proper applications design, the operator may never know if the station is on-line or off-line.

Conclusions

The microcomputer is only beginning to enter the DP realm. It promises to be a significant ally in designing and implementing applications. It is important, though, that we observe the following points:

- The things the micro does well differ from those that the larger machines do well. Instead of just trying to move the mini software down to the micros, try to judge the usefulness of each based on its actual strengths.
- The lessons learned during the 1970s about orderly software development and use do not need to be abandoned when you approach micros. Keep the standards for quality software high. The software is there to support them.
- Don't wait too long to examine your needs in light of existing micro capabilities. Now is the time to assert a leadership role in your organization's inevitable plunge into the microcomputer revolution.

Tibbetts is vice-president of research and development at The Datalex Co. in San Francisco.

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SYSTANT: THE EMERGENCE OF A NEW DPER

Perhaps if I'd been using my fourth-generation Executive Time Management software package, the mistake never would have happened. But I couldn't even get the darn thing loaded, so I put the manual in my bottom drawer and fell back to my zero-generation paper-and-pencil calendar. And somehow I managed to schedule two lunch appointments for the same day.

Jake, the DP manager at Ninth National Bank, suggested that we all have lunch together and, because of my mistake, I should pay. My stupidity left me with no alternative. I called Lorene at the DP section of Glittering Mines. She agreed to the lunch a trois — at an appropriately expensive French restaurant. It was going to be an expensive mistake.

By Gerald M. Weinberg

After lunch, emboldened by a stomach full of lemon sole, I decided to talk about the software difficulties that engendered this situation.

Jake was immediately sympathetic and responded, "You're not the only one who has trouble with so-called fourth-generation software. We spent $75,000 for a 'user-friendly' financial analysis package. It's so unfriendly that all the users cursed me for buying it."

"You bought the wrong package," Lorene said. "For the same price, we got a financial analysis package that really is user-friendly. Our users love it, and they love us for buying it for them."

"What package is it, Lorene? Perhaps Jake could get a trade-in."

"It's called Moneypenny."

"But that's the stupid package we bought!" Jake roared. "Your users must be a lot smarter than ours."

Lorene looked puzzled. "If you knew our users, you wouldn't say that. Maybe you got a different version of the system."

"Ours is Version III-A."

"So is ours. I don't understand it."

While Jake and Lorene ran through several other possible differences, I looked for loopholes in the lunch bill. I couldn't see any way out of the bill, but I did see an opportunity to earn it back. "I have an idea," I volunteered. "Perhaps there's something different in the way you two managed the Introduction of the package. If you're interested, I can tackle the question as an add-on to my consulting contracts."

After a short negotiation, we agreed that I would interview a few users in each organization, so long as it did not add anything to their costs. If I found anything interesting, then it might lead to future contracts.

At Ninth National, however, the users taught me nothing except a few new swear words. At Glittering Metals, the users were less emotional, but I didn't learn anything at all.

Fieldwork Observation

I decided I must have been mistaken. There was something about Moneypenny that made it more usable at one place than at another. I asked Cliff, the last user I interviewed at Glittering Metals, if he would let me watch him use Moneypenny. I promised to sit next to him and say nothing, regardless of what happened.

It seemed to me that Moneypenny was an average fourth-generation package. It had some nice features, but it didn't meet my human engineering standards. Still, Cliff seemed to be getting along all right — until the screen flashed this ominous message:

```
*** ILLEGAL ENTRY ... COMMAND REJECTED ***
```

Cliff pondered the message for a few minutes, then hit a few keys. Another message:

```
*** RECURSION ATTEMPTED IN PARAMETER ***
```

"What's recursion?" Cliff asked.

"It would be better if I remained an observer," I said, a bit cowardly. "Just do whatever you would do naturally."

"Well, at least tell me what's a parameter."

"Don't be angry, but I promised not to say anything."

"OK, then I'll call the Hot Line. Scott or Leatrice should still be there. They usually work late."

"Who are Scott and Leatrice?"

"They're the Hot Line programmers for Moneypenny. Who did you think I would call?"

Being a good consultant, I played it cool. "Oh, the Hot Line programmers, of course. I just didn't know their names."

Cliff talked to Leatrice, who gave him a magic formula to put the hex on his unwanted recursion. The hex worked, unlocking the screen and sending Cliff merrily on his way. After the session, I asked him if he ever had any trouble with Moneypenny.

"Trouble? No, nothing I couldn't handle. It's a real user-friendly system."

Visit to Hot Line

Cliff never mentioned Scott or Leatrice, but I thought I'd pay a visit to the other end of the Hot Line. It turned out the Hot Line was an institution at Glittering Metals, dating back to the dawn of time — punched-card tabulating equipment.

"Programmers serve on the Hot Line mostly when they're between projects," Leatrice told me. "It's good experience — you never know what you'll get into."

"What kinds of things?"

"Everything and anything, I suppose."

"That's not very helpful. Don't you have a job description?"

"Not really. It's kind of a temporary assignment, so you just keep your old job category. I'm a senior programmer, but we have systems analysts, too. And one systems programmer."

Later, Lorene told me the job of people on the Hot Line is to do "whatever is necessary" to make the users happy. In the old days, that

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might have meant running off an extra copy of some report they had lost and carrying it up to them. Now, it frequently meant figuring out how to get their user-friendly systems talking to them again.

"It sounds to me like a hot seat, rather than a hot line. What kinds of people do you put in that job?"

Lorene pondered my question for a few minutes before answering. "I guess I look for generalists — people who can do a little bit of everything. They've got to be technical enough not to be snowed by systems problems, but they've got to be good communicators — good listeners, especially — above all else. Not too many of our technical people are good listeners."

"What else?"

"Well, they're problem solvers. They don't get stuck. Somehow, they get things going."

After a little more investigation, I went back to Ninth National. I explored the question with Jake, but he said they had nothing like the Hot Line. I then asked him if they had any user-friendly packages that had worked well.

"Sure," he said without hesitation. "There's a statistical analysis package used in the personnel department. They've never had a moment's trouble with it — but they certainly don't have a hot line."

I arranged to visit the personnel department, where I soon discovered that their "hot line" was Arlo, a senior records clerk who had learned to use the statistical package when he did a master's thesis in personnel management. Arlo was the one who had suggested the package in the first place, and he was a gold mine of miscellaneous information about how to make it work.

Arlo was not a part of the DP department, so Jake didn't even know of his existence. All the same, Arlo seemed the critical difference between success and failure for the statistical package.

Cultural Broker Role

When I returned from the trip, I discussed these events with Dani, my partner and resident anthropologist. "What you seem to have discovered," she said, "is what anthropologists call a cultural broker."

"Tell me more."

"Cultural brokers exist wherever two different cultures must interact, in spite of their different languages, value systems, customs and other barriers to communication. The cultural broker is a person who happens to have one foot in each culture, so can act as a go-between whenever the need arises."

I was impressed with the aptness of this description. Users often say DP is a different culture — and DPers certainly feel the same way about their users.

Even so, cultural broker wouldn't do. Who would want to be called senior cultural broker? Besides, in the DP business, we must coin new terms for old concepts. That way, everything we do sounds as though it's on the leading edge.

A series of visits to other clients convinced me that behind every successful user programming system there was a cultural broker. Sometimes they were right out in the open. Sometimes they were so well hidden they almost blended into the wallpaper. But they were always there.

As I listened for a good name for this function, I discovered cultural brokers under such titles as customer service representative, user service specialist, technical specialist (with a variety of subtitles), consultant (again with subtitles) and systems engineer.

I found even more cultural brokers masquerading under conventional titles, including programmer, analyst, systems analyst, systems programmer, trainer, data base administrator and business analyst. And when the cultural brokers were in user departments, almost any title was possible.

Proper Blend

Finally I decided to coin my own title. I started with the two major aspects of the job:

- Technical knowledge of a system.
- Interpersonal skills used to assist people.

Blending "system" and "assistant," I got systant.

It's easier to pronounce than systems assistant and it can even be considered a pun. All in all, it should do the job until someone comes up with something better. Besides, it almost rhymes with mutant.

Where Are They?

For the past two years, I've hunted for systants. Though they were called by different names, attached to different departments and had different job descriptions, there were systants everywhere "user-programmed" packages were used successfully.

The following are just a few examples:

- A large bank has a department called the Information Center staffed with technical specialists. Organizationally, the Information Center reports to the DP manager, but physically, it is in a separate office close to the two major user groups. The technical specialists support whatever packages are purchased for users with activities such as training new users, consulting on immediate problems, helping users write specs for add-ons and negotiating fixes with vendors.

According to the DP manager, the title of technical specialist was purposely vague, so as not to prejudice anyone against doing anything necessary to get the users what they want. "Sometimes they come over here and convince us to do things for the users that I can't believe I'm agreeing to. And I hold their paychecks!"

- In the actuarial department of one insurance firm, buying software packages is an established practice. Whenever a new package is needed, one of the younger actuaries is assigned the job of making the selection. After a package is selected, the actuary who chose it becomes the systant for that package — under the informal title of technical specialist for the XYZ system.
- Glittering Metals had their hot-line system, in which the systants were any technical people who happened to be underloaded. In several other installations, essentially the same system was in place with no formal recognition from management. Users simply learned the name of someone in DP who "knew the answers," and that person's name was passed from user to user.
- In another bank, the investment analysts were happily using a new system without any outside help. In fact, they were so happy with the system that they started to swamp the bank's on-line data base. A data base specialist, who was sent upstairs to investigate, discovered their "programming" not only was grossly inefficient in terms of both their time and computer time, but also contained many subtle bugs that invalidated their analyses. The investment manager requested that the data base specialist be assigned permanently to assist the analysts — thus creating a new systant.
- In the marketing department of an electronics manufacturer, this informal hot-line system changed when the formal systant departed for greener pastures, leaving the users without their contact. Without too much trouble, one of the heaviest users of the program generator acquired the systant role. The job moved out of DP entirely, but be-

Behind every successful user programming system is a systant.

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cause management had not known it was there in the first place, it did not cause a ripple at the upper level.

Some of the marketing users, however, thought they were probably not employing the full power of the package. Without technical support from DP, they shied away from some of the more "technical" features. In one specific example, someone tried to use a formatting feature, but did not succeed. When the systant couldn't figure out what was wrong, the user decided to use a less convenient format.

The situation in the electronics firm suggested to me that I might be able to find places where some fourth-generation software was not used because no systant was available or forthcoming. It's a bit difficult, though, to attribute causes to events that didn't happen, so I had to make some inferences. For instance, I noted that the larger the group of potential users of a package, the more likely one of the users was to become a systant.

In the case of Ninth National and the Moneypenny package, there were only three users who had actually seen a need to try the system. Evidently, none of the three had sufficient motivation or technical bent to get it going and it withered away on a shelf.

In a situation like that, the DP department could have increased the chances of success by supplying a systant, at least during the early stages. Or they might have tried to create a larger user community.

Even though a small group of users is less likely to create their own systant, there will always be some individuals who have just the right combination of skill and motivation to succeed with a package without assistance. Some of these individuals become missionaries for the new system, recruiting other users with such enthusiasm that you begin to suspect they're receiving a finder's fee for each convert.

Actually, their biggest payoff seems to be acquiring the role of systant, with concomitant respect and attention from their colleagues.

What the Future Holds

In the early days of the automobile, every car carried both a driver and a mechanic — or, if you like, a user and a programmer. It must have been a great sales ploy in 1910 to assure the car buyer that the new machine would "eliminate the need for mechanics." But after 70 years, although we may not see them every day, we scream for a mechanic when something goes wrong.

User-programmed systems are supposed to "eliminate the need for programmers." But the simple truth is they're neither that well designed nor that well implemented, and they won't be for a long time. And the more important information systems become to their users, the more critical the programmer's role will become. Think how anxious you get when your car won't start — even if you have two cars.

I think both programmers and analysts will still be around for a long time. But their roles will change. One such role is that of systems programmer. Installing and maintaining user-programmed systems is straining the supply of competent systems programmers. As a result, some applications programmers are moving in an even more technical direction.

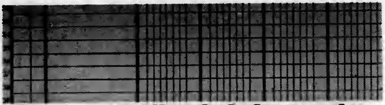
Another changing role is that of system designer. If these systems are to become truly user-friendly, we are going to need 10 times as much work on their designs before they even reach the advertising department. And it's the kind of work that systems analysts have traditionally done with users — but far more intense.

The greatest new demand is for programmers and analysts to move in the other direction — not so much further from the technical side as closer to the user side. The systants I have encountered have retained or acquired the basic technical skills of programming, but also have more than the typical programmer's share of "people skills."

These systants, whatever they are called, are first and foremost good listeners. Second, they tend to be generalists — interested in more than one thing and capable of learning new things quickly. And this includes a strong interest in people; they like people and enjoy helping them.

Good systants are good problem solvers — they get the job done, regardless of what it takes. If fourth-generation software is going to succeed, we will need a lot more of these people. It would pay us to start finding and training them right now.

Weinberg is a consultant and trainer at Weinberg and Weinberg in Lincoln, Neb. His most recent books are Understanding the Professional Programmer *and* Rethinking Systems Analysis and Design. *(Little, Brown and Co.).*



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Management must direct change, if success is to be secured. Return on investment arguments, not technical ones, are required to justify the conversion of the office worker's desk into an electronic workbench. Traditional methodologies for building computerized systems have not adequately supported management's need, which is stronger now than ever before. The price of past mistakes has been missed business opportunities and escalating costs. The price of future mistakes will be much higher...

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THE CRISIS IN DP EDUCATION

A study done by the Computer Science Board in 1980 stated: "Compared with all other university disciplines, the computer science profession shows the highest vacancy rate, coupled with the largest upswing in starting salaries. . . . The percentage of computer science faculty who leave academia for industry is twice as high as for any other scientific profession."

This finding underscores the gravity of the problem of faculty erosion in the computer sciences. The study also found:

- The supply of computer science Ph.D.s is equal to about 20% of the demand.
- About 60% of graduating Ph.D.s in computer science take careers in industry.

A Place to Learn and to Grow

In annual two-week sessions offered in June and August, the National Computer Educator's Institute (NCEI) provides hardware and software technology training for university and community college teachers. Each year, 80 to 100 teachers attend each session.

In today's education crisis, severe shortages of qualified teachers have replaced past problems of insufficient or outdated hardware. The current problem is finding enough teachers to educate the number of students needed to meet industry's personnel demand, and most experts believe the problem is going to get worse. The solution appears to center on two issues: maintaining technical currency for existing computer educators and providing training for teachers who are able to migrate into the computer studies area from other related academic areas.

In both issues, NCEI has made a contribution. Originally the brainstorm of Dr. Joseph M. Kinzer of Central State University, the institute is now cosponsored by Central State University and James Madison University in Virginia and is supported by *Interface, The Computer Education Quarterly*.

Each year about 40% of attendees are repeaters from previous sessions. This year, several teachers found funding support from local companies that recruit heavily in the home teacher's area.

In addition to formal courses, the institute sessions have provided an opportunity for teachers to exchange teaching methods, ideas and support. The teacher shortage has left most departments understaffed, departing graduates often earn more than the teacher and classrooms are overflowing. Little time is available to reflect on what subjects should be taught and how they can be taught. At NCEI, teachers can use their free time for communication and reflection.

The Institute's sponsors attempt to expose teachers to both educational practices and industry training needs issues by balancing its own instructional staff between college educators and industry consultants and experts.

While the teacher shortage will not go away overnight and academic education still often falls short of industry requirements, NCEI provides a quality solution, if only a partial one.

The two-week session costs $588 for the Virginia session and $353.40 for Oklahoma session, not including transportation. Attendees select from a series of courses and receive graduate credit for completing that course. Two [illegible]sions were offered in 1982.

More information on [illegible] available from Dr. Z.S. [illegible] at James Madison [illegible] Dr. David Chance at [illegible] University.

- The undergraduate student demand for computer science has doubled since 1975, but the total number of Ph.D. graduates has dropped during the same period.
- Fewer than 100 of 248 Ph.D. graduates chose academic careers in 1979, and those graduates had more than 650 different academic positions from which to choose.

A state senate subcommittee in California has reported that by 1990, California alone will be 50,000 computer scientists short if the present trends continue.

"The problem is extremely critical. We are losing ground already to Japan," according to Prof. Daniel Couger of Colorado State University. Japan, with only half the population of the U.S., outproduces it by 25% in the area of graduate engineers. The total number of graduates in computer-related fields in Japan is 21,000, compared with 16,000 in the U.S.

"Unless this trend reverses," the Computer Science Board report continues, "this country will soon lose its lead in computer technology" and will be unable to meet the increased need for trained personnel, both in industry and in an exponentially increasing technological society. Since 1975, "an explosive growth of the field [has occurred] with no commensurate increase in computer lab facilities, or in the number of computer science faculty." The faculty erosion "seriously threatens our ability to conduct basic research and to train the next generation of computer scientists," the report continues.

Mass Exodus

The dilemma is that undergraduates, lured by high industrial salaries, are siphoned off to industry before they enter the graduate pipeline, while universities, unable to recruit sufficient Ph.D.s to fill existing entry-level positions, are also not able to hold the professors they already have. "There's either no faculty at all, or they leave after two years," said Prof. Daniel McCracken of City College of New York. Faced with meager research facilities, untenable teaching loads, lack of contact with industry applications and salary compression, faculty are decamping in droves.

A study done by the National Science Foundation (NSF) in 1979 showed that only one in 46 graduates with a bachelor's degree in computer science goes on to take a Ph.D. They are lured away by entry-level industry salaries averaging $25,000, with accompanying stock options, equity positions and state-of-the-art equipment.

Spot-checks across the country revealed that:

- The University of California at Berkeley, which before Proposition 13 was on the leading edge of the educational zeitgeist, was forced to turn away 200 freshmen from fall enrollment.
- "Departments like ours won't survive even one year," said Donald Martin, chairman of the Computer Science Department at North Carolina State University at Raleigh. "I give us until fall of '82. If no help is forthcoming, instead of 300 freshmen, we'll be taking 50 freshmen." Twelve faculty short and facing 20 computer science class sections without teachers for the fall semester, he did not exaggerate the gravity of his situation: "We've already turned away 200 freshmen for fall."
- "With no money, no support, no buildings and no equipment, we are fighting for survival," said Emile Atilla, chairman of the Computer Science Department at California Polytechnic State University in San Luis Obispo. Atila has seven unfilled faculty positions and is able to offer an associate professor a salary of only $25,000.

Fresh from unsuccessfully hustling for faculty and grant money last year, he said, "I was trained as a computer scientist, but more and more I feel like I'm selling shoes."

The prestigious "Ivy League" of computer science departments are managing to hold their own. Schools such as Duke University, MIT and Pittsburgh's Carnegie-Mellon University are able to attract and hold top robotics experts and Nobel Prize winners and are consistently deluged with very high-quality Ph.D. applicants for their limited graduate openings. But they are an anomoly. The majority of schools do not fare so well. Hardest hit are the financially decimated state systems, caught in the recessionary cross fire and forced to struggle with an inadequate tax base and noncompetitive salaries.

Even such seemingly immune institutions as Stanford University and the North Carolina Research Triangle, which exist in a unique nexus of government labs, think tanks and multimillion-dollar electronics ventures, are having trouble. Stanford recently lost two full professors — both deeply involved in integrated circuits design — to nearby Silicon Valley. Flourishing start-up ventures and firms able to offer salaries of $100,000 with stock options are seductive. Many Stanford faculty never return from the two or more years of vaguely termed "sabbaticals" at well-funded government and industrial research centers like Xerox Corp.'s Palo Alto Research Center, Hewlett-Packard Co.'s Computer Science Center and the Stanford Research Institute where "faculty can play with [microcomputer] toys for years at twice the salary," according to Stanford Ph.D. candidate Tom Dietrich.

Big Bucks

The intense competition for computer specialists in industry has produced record salaries:

- Entry-level salaries for graduates with a B.S. average $24,000 to $29,000.
- Recent graduates with a master's degree and no experience earn $32,000.

- New Ph.D.s commonly earn $38,000 to $40,000.

Experienced associate professors making the job switch into industry receive offers as high as $45,000, according to an NSF study done in 1981. The average salary increase for faculty who changed from university to industrial settings was cited as $10,121.

In stark contrast, the salary offered a new Ph.D. entering the teaching profession ranged from $27,000 at small schools to $35,000 at prestigious private universities. Salary compression further aggravates this situation. Starting faculty salaries track industry well, but at the six-year mark — or associate professor level — salaries do not hold parity. (Salary rates that existed when professors were hired six years ago would not match salaries commanded in 1982 by nonexperienced Ph.D.s.)

The salary curve continues: Associate professors' salaries average $29,000 at smaller schools, up to $40,000 or $44,000 at Top-10 institutions. Full professors' salaries average $40,000 to $45,000 at smaller schools and shoot up dramatically to $48,000 to $85,000 at top schools. Such high salaries are rare, however, and are generally reserved for computer science supernovas — robotics gurus or Nobel Prize winners.

All faculty salary figures mentioned are commonly augmented by summer research supplements equalling one-third of base salary, consulting fees (which average $15,000 to $20,000 annually), book royalties (averaging $5,000 to $100,000 a year, depending on the book and author) and lecture honoraria.

Lab of One's Own

An NSF "Employment Decisions Study" made in 1981 yielded another surprising result: "Decisions to change jobs commonly result from policy factors, rather than from facility and salary considerations." The three most commonly cited reasons for decisions to leave academia were what NSF researcher Ken Curtis called institutional disincentives — untenable teaching loads, tenure and promotion policies, inadequate research facilities and, only in last place, salary.

"Until universities change their habits," said Bruce Barnes of the NSF in Washington, D.C., "faculty will continue to leave."

A prime disincentive has been obsolete and inferior research equipment. Laboratory space has remained nearly fixed since 1975. Universities chronically fail to recognize the inherent laboratory nature of the field. According to Edward Feigenbaum, a professor at Stanford, "They don't understand. Computer science uses computers like a lab, just like chemistry does. Computer science can't get done with pencil and paper." Nevertheless, the study revealed that the best university research labs' annual capital investment averages only $25,000 per scientific researcher, compared with industry's annual $50,000 to $75,000 per researcher. Universities have refused to reallocate money to upgrade meager research facilities, have turned a deaf ear to faculty complaints and have allowed their departments to drift away from practical industry applications.

"Teachers are basically scientists intent on pursuing their research in a quiet, conducive environment," Tom Binford of Stanford said. Universities seem bent on thwarting this simple goal. University policies pile on time-consuming committee work, limit the bread-and-butter income that consulting affords, continue to encourage publish-or-perish philosophies and enforce rigid implementation of outdated policies.

Pressures on faculty are intense and unremitting. Most professors moonlight as consultants to make ends meet. "Professors have to do outside consulting to live. They're killing themselves," Feigenbaum said. Yet consulting is looked upon with suspicion by many university administrators who limit consulting hours to 15% weekly. University of California's Prof. Michael Harrison, vice-president of the Association for Computing Machinery (ACM), rises at 5 a.m. to perform a precarious professorial juggling act of teaching, consulting and administrative chores. "I work like hell," he said.

The professorial lifestyle has undeniably changed. On-campus amenities have decreased or disappeared. The image of the cardigan-clad, pipe-smoking professor attending leisurely faculty teas and hosting civilized wine and cheese parties for students has become obsolete. Teaching now leaves little time for contemplation, let alone research. Burgeoning undergraduate enrollment and spillover students from other disciplines vaguely searching for "computer literacy" have led to typical teaching loads of 1,000 students. At Stanford they are "crammed in like herrings in a box," Feigenbaum said.

Until universities change their habits, faculty will continue to leave.

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In recent interviews with computer science department chairmen across the country, I have heard some suggestions for improving the situation. They run the gamut from the conservative and short-term to the "throw away the drawing board" approach. All, however, addressed the need for cooperation between industry and academia that, until now, has not existed.

Survival Strategies

The majority agreed that if the U.S. is to work its way out of this educational dilemma, government agencies and corporations must act in concert to provide financial assistance through fellowships, traineeships, stipends and programs designed to shore up existing experimental facilities. Industry and government can and should make substantial financial contributions (which will have the added advantages of tax breaks and public relations benefits) by endowing department chairs and by allocating unrestricted funds grants that could:

- Bring university labs more on a par with the best industry labs.
- Be used as salary supplements to alleviate the salary compression problem.
- Be used as stipends, fellowships and traineeships for underwriting graduate students to give them an incentive for staying in graduate school and to reduce the attractiveness of immediate industrial employment.

Finally, industry and government should sponsor cooperative ventures that focus on specific applications, modeled along the lines of Stanford's Center for Integrated Systems, which is backed by 20 industrial sponsors that each contribute $250,000 to the project.

Rotating sabbaticals between industry and the universities for periods of from one to two years could prove an effective exchange that would enhance the skills and increase the currency of all parties.

Universities themselves can and should take immediate steps to lighten the combative and strained atmosphere that presently exists. They must reevaluate severely strained budgets and reallocate funds to areas in which they can best be used. They must produce capital resources for experimental research and lab space and come to recognize the inherent laboratory nature of the computer science field. They must refocus time priorities and relieve professors of undergraduate teaching burdens and peripheral committee duties in order to free valuable faculty time for graduate supervision, research or writing. This could be effected by hiring outside staff or temporary visiting faculty to fill the gaps. In short, universities must allow professors to be scientists and to regain their waning sense of autonomy and professionalism.

Universities must face the salary compression problem squarely and implement a system of adjusted salaries for separate disciplines — as has been done in the medical and legal professions — and bring salaries into parity with the marketplace. Languishing arts and humanities departments have "milked the cow of computer science long enough," according to University of Missouri's Ron Jones.

Some of those interviewed favored letting the marketplace right itself: Jones continued, "What technology creates, technology takes away. Time will move to eliminate the problem. In 10 years, users will shop for software from a catalog or utilize application-generating programs. Fewer applications programmers will be needed, and the differential effects will play themselves out in five, 10 or 20 years. We shouldn't change anything," Jones stated. A study by the U.S. Department of Health and Human Services' National Center for Educational Statistics supports this theory; it projects student loads to drop 25% in all disciplines by 1989.

Orin Toulbee, of the University of Pittsburgh, said Ph.D.s are needed only for their overall vision of the field and to effect curriculum changes. Students could learn basic skills on the job or at the high school level, freeing universities to concentrate on producing graduate students and advancing research.

Training vs. Education

"Computers belong out of the university," Stanford's Lou Fine said. Many of those interviewed believed the solution would be found outside the normal university sphere in the creation of alternative educational settings modeled on existing nine-month trade schools or in-house plant schools like Wang Laboratories, Inc.'s Wang Institute, IBM's in-house schools or the traditional U.S. Army approaches to training new recruits. The university approach is overkill, they said, for teaching the basic computer science courses necessary to produce the required cadre of future programmers and systems analysts — the "grunts" of industry.

Government and industry have been active in funding areas, but not active enough. Honeywell, Inc. has initiated a computer science chair at the University of Minnesota. Stanford has a computer science Fletcher Jones Chair; IBM has funded chairs in management information systems (MIS) at the University of California at Los Angeles, Carnegie-Mellon and Stanford; and Intel Corp. is considering a $150,000 chair at Carnegie-Mellon.

IBM gave 40 unrestricted funds grants to Stanford in 1981. Chemstrand gave a $200,000 grant to the Chemical Engineering Department at North Carolina State; the interest went to supplement faculty salaries.

Bechtel Corp. covered a student's plane fare to the University of Michigan for an interview and offered him two summers of consulting. He was subsequently hired.

Federal agencies have begun to allocate funds for experimental research. The Coordinated Experimental Research Program of the NSF is investing $5 million yearly to improve experimental computing facilities at selected universities throughout the country and is presently involved in the second round of the selection process. The Department of Defense-sponsored Department of Advanced Research Projects Agency is funding $20 million of on-campus experimental research this year.

Other Solutions

Other innovative solutions are also being attempted:

- ACM is creating a summer institute to retrain faculty recruited from related disciplines via a five-week crash course to teach MIS — "A quick fix," ACM Chairman Chuck Hickman called it.
- The Computer Science Board, composed both of chairmen of 83 Ph.D.-granting departments and industry observers, held their biennial meeting last July to explore issues of staff retention.

In spite of all this, "It's like trying to stop an ocean liner," Hickman said. "You need lots of lead time and even after you apply the brakes or try to make a turn, it takes a long time for anything to happen."

Burton is a writer specializing in technology issues. She lives in Oakland, Calif.

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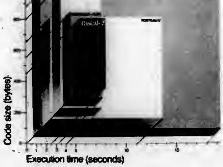

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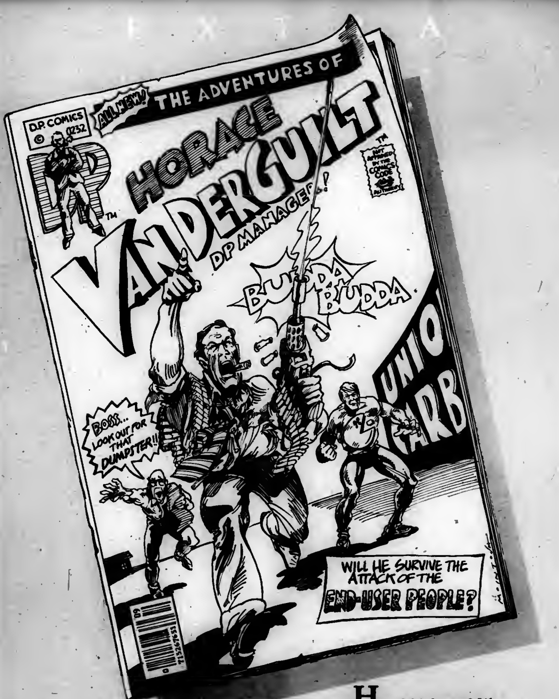

How did it happen? Life was so perfect. As a DP manager, Horace Van Der-Guilt was on top of the world. Management listened to his every word. Users cringed and bowed as he walked into a room. Headwaiters knew him by name. And now? Shackled to a cart along with his senior programmer, Ray Honto, he was on his way to meet his maker.

As the cart creaked and groaned its way to the site of their execution, the wild, screaming rabble could be heard all around: "Where's your structured Cobol

By James Van Speybroeck

now, Bozo-Brain!" "So much for our payroll reports being two weeks late all the time, Van DerGuilt!" "Show the executioner your CDP papers, you turnkey turkeys. Maybe he'll give you a blindfold!"

But Horace was oblivious to the jeers. He could only shudder in disbelief at events. Five years ago, in 1982, things had been so different.

He recalled December 1981. The DP staff was looking forward to the holidays. Horace had just told one of his junior programmers to ignore the request from the accounting department for a change in the format of the trial balance. "If they don't like it the way it is, let 'em eat cake!" Horace chuckled to himself, contemplating his absolute power.

At that point Ray Honto, the senior programmer, walked into Horace's office. "Did you read in the 'Forecast '82' issue of *Computerworld* about information centers, Boss?"

"Yes, Ray, I glanced at it, but it's a ludicrous idea." Horace continued in a pontifical manner. "Ray, the thought of those peasants being able to change their applications is absurd. Half of them think CICS is a pesticide for the Medfly. Mark my words, the whole concept won't last any longer than the Hula-Hoop."

"But, Boss, some of the largest vendors are experimenting with the concept."

Horace was becoming a bit irritated. "Ray, my boy, if you ever want to leave the slums of programming and enter the paradise of DP management, you're going to have to realize some of the basic axioms of data processing. 'Power to the peasants' is a theme we all push. It's good PR. Every year or so we make a few grandstand plays about how we want to make the user happy. You don't sell hardware to top management by stressing the importance of experienced, expensive and all-knowing personnel like myself. This year it's 'User-Friendly'; next year it will be 'Mr. Happy Talk — the new conversational language.'

"Believe me, Ray, anything that will get the users off our backs for a while is standard operating procedure. In a few months, this whole affair will blow over. By this time next year, the only thing those information centers will be used for is supplying the names of local floppy disk salesmen." Horace was laughing uncontrollably at his joke as Ray slunk out of the office.

CORPORATION

One Year Later

"Boss, I'm really concerned about this. Last week, the financial department modified two of its month-end reports without any DP advice and consent." Ray was biting his nails as he waited for Horace's response.

"Isn't that beautiful, Ray?" Horace was pointing to the blue marlin mounted on his office wall. Horace had recently returned from a vacation in the Bahamas. "Yeah, Ray, that taxidermist did a beautiful job. I tried to catch that giant for four days and then it came to me. If you don't have the hardware, you can't do the job. Oh, the captain of the schooner balked a bit when I mounted the 50-caliber machine gun on the stern, but 20 rounds from that baby and old Horace had his marlin.

"Now, Ray, what seems to be the problem?"

Ray repeated his statement.

Horace gazed lovingly at the marlin for a few seconds and then replied, "Don't worry, Ray. I'll call the head of the financial department. He's up for a promotion and I'll feed him some gibberish about transmission interference and how his files could be destroyed unless he lets us review the fix. In five minutes I'll have him eating out of my hand."

Ray left, unconvinced.

That afternoon Horace called the financial manager and told him that the modification was causing blurring of telecommunications data transmission and that the Federal Communications Commission had initiated an investigation concerning possible guideline violations.

By the time Horace had finished, the man was in tears. By 6 p.m., the financial manager was committed to Bellview for observation, and Horace had a signed statement from his staff indicating they would never mess with software modification again. Ray was relieved, the staff was happy and Horace just looked at his marlin. "If I'd had a howitzer, I could have bagged that fish the first afternoon."

1984

"Ingrates! Unappreciative jerks! Thankless bullies!". Horace's tirade had now entered its third day. The summer of 1984 was very warm, but did not come close to the heat generated by Horace over the industry switch to user-oriented software. "I ask you, Ray, a payroll clerk allowed to access a Vsam file? The next they'll want is intermarriage between programmers and regular staff!"

Ray had never seen Horace so upset. The decision of the mainframers to stress software development with user-friendly languages had significantly changed the focus of data processing. Backlogs were diminishing at an alarming rate. Users were modifying their own application packages with frightening success. Horace was down to one day operator, one junior programmer, Ray and himself.

"And I'll tell you this, Ray. It won't stop here. These end users are getting bolder every day. It's just a matter of time before they take over all together. First it was ADRS, then Mapper, then Natural and now look what's been introduced — 'Natural Light: The Language for All Users.' For *all* users? Why don't they just stick a knife in my heart?"

"But, Boss, maybe it's not all that bad," Ray tried to console Horace. "With more and more program maintenance being handled by the user, you'll be free to work on custom packages, data communications network problems and efficient storage usage. They can never replace the DP manager, Boss."

"Oh, no, Ray? Have you been in the executive washroom lately? Right there on the wall, in blatant graffiti: 'Drop in to DP sometime. You'll see a Horace of a different color.' And I know who wrote it, too — that lousy finance manager. He still hasn't forgotten that Bellview thing.

"Ray, I'm a reasonable man. I didn't mind Idcams with CICS. Half the users couldn't understand the menu response messages anyway. But now, Ray, all of the vendors have those subversive information centers, not to mention their demonic user languages. Did you read CW this week? They predict that within two years, all mainframes will support 'Mr. Good Programmer,' the new common Ansi user language.

"The handwriting is on the wall, Ray. Today, Mr. Good Programmer; tomorrow, DP personnel will be hunted down like dogs."

"Come now, Boss, don't you think you're overreacting?"

Horace's expression was almost crimson as he replied, "Ray, do you think production control is going to forget their continual two-week backlog? Do you think quality control will ever forgive us for truncating all significant digits from their chi-square tests and my blaming it on a bad print chain? They're jackals, Ray, and they're just waiting to get even."

Ray stood silently as Horace just gazed into space with his ever-more-frequent thousand-yard stare. Ray thought, "He's close to the deep end. Anything could happen now."

After a minute that seemed like an eternity, Horace turned to the wall and focused his eyes on the blue marlin. He slowly angled his head toward Ray, a cruel smile forming on his lips. Half talking to himself, half talking to Ray, he started slowly in an almost undetectable whisper, "If I bagged that marlin, I can bag those end users. I didn't spend 10 years attending Datapro seminars for nothing."

Suddenly the old Horace was back. He began barking out orders with bulldozer certainty: "Ray, hire a word processing secretary. Tell personnel we need the extra help to implement Mr. Good Programmer."

"Right, Boss."

"Then, Ray, I want you to send a letter I'm going to draft to every constituent society of Afips, DPMA, ACM, all of them. Send it by Ecom. We're going to fight. I'm going to form a right-wing, provisional group of dedicated American DP professionals. We're going to wipe out this cancer of user-driven computing once and for all. I'm going to lead my colleagues in a holy war to restore DP to its rightful place. By the time I'm done, Ray, DP professionals will regain their superiority and arrogance."

One could almost hear the strains of "God Bless America" as Horace spoke. "Go for it, Ray. We have a way of life to defend."

Ray rushed out of the office to obey Horace's commands. But on the way out he couldn't help but think to himself, "Horace of a different color. That's pretty clever."

1986

The next two years were not kind to Horace and his band of crusaders. He had managed to recruit only Ray and one Pac-Man devotee. Their only assault — against the Union Carbide Information Center in Charleston, W.Va. — was a dismal failure. Unfortunately, the National Computer Conference has had very few sessions on DP guerrilla tactics, so Horace, Ray and the Pac-Man player didn't really know what they were going to do. When Horace walked into the center and claimed the property for all free-thinking DP professionals, security promptly threw him into the same dumpster they were using for the disposal of the last of their hardware manuals.

However, a reporter on his lunch hour happened to notice the fiasco;

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that night, a *Charleston Tribune* headline read, "DPers Attempt to Hold End Users Hostage." Network TV latched onto the story and the next morning all DP personnel in the U.S. were seized.They were confined in detention camps until they swore an oath of allegiance to the Independent End Users of America and promised they would no longer carry RPG debugging templates in their shirt pockets. Since the alternative was on-the-spot execution, most of the DPers gladly complied.

Horace and Ray managed to escape the dumpster. The Pac-Man Kid gave himself up when he was promised amnesty and a free Big Mac for every game of Space Invaders he won.

For over six months, Horace and Ray were hunted fugitives. During their flight they supported themselves with some contract programming and occasionally were fed and housed by DP sympathizers. Ray, ever-mindful of his programming background, even managed to use some of his time productively by writing a novel, *The Best Macros to Code While in Hiding*. But survival occupied the majority of their time.

1987

It was winter and Horace and Ray were ensconced in the Cochituate State Park in Massachusetts. Cold, hungry and surrounded by the commonwealth militia in force with the Framingham Blue Birds (Chapter 196), they knew the end was near.

"You know, Ray, I look about me and all I can think of are those immortal words of David Frost, 'The woods are still and deep.'"

Ray pondered on whether he should mention that Horace's knowledge of poets was about as acute as his knowledge of guerrilla warfare, but decided not to kick the man when he was down.

"At least we gave them two years they'll never forget. I may never receive the Harry Goode Award, Ray, but there are a legion of silent-majority DPers out there who will solemnize the name Horace Van DerGuilt in their hearts forever." At that, Horace broke into a chorus of "To Dream the Impossible Dream." When Ray reminded him that his falsetto tenor might lead the militia to them, Horace replied, "Let them come. The immortal Horace is ready."

Twenty seconds later, they heard the bullhorn and spotted the unmistakable gold button of a Blue Bird tam. "Horace Whatever-Your-Name-Is and Ray Honto, lay down your IBM reference cards and surrender peaceably. Your NCC '87 conference badges won't be confiscated."

Armageddon

The cart stopped. Ray and Horace were led up the stairs of the hastily constructed scaffold, in front of the local network control center. Ray was to be hanged, drawn and quartered by a Uarco burster. Since Horace had been top management, he was given a choice: the burster or a firing squad of laser printers. Horace chose the latter.

The executioner, a technology support manager, was strangely compassionate. He offered both men a last cigarette. Horace accepted, but Ray declined since he had caught a cold in the Cochituate State Forest and didn't want to irritate his throat any further.

Because of his previous officer status, Horace was granted a last statement. The users were as silent as Apple terminals as Horace began: "You end users will little note what I say here, but you'll long remember what happened here. Never have so many done so crummy much to so few. When your end-user help disks don't come through, when your user education and information centers dry up, when your tech support group goes down the drain, don't come running to me. After today, you won't have Horace Van DerGuilt to kick around anymore.

"Listen to that Laser 'zap' and to that burster 'pah-wok' and know that you've destroyed the last DP manager in America and your last hope for efficient software modification."

Horace then asked to be allowed to sing two verses of "I Did It My Way," but was refused because the printers and burster had to be returned by noon to prepare a payroll.

It was fast. It was silent. It was final. A "zap," and "pah-wok" and Horace Van DerGuilt and Ray Honto were gone, not with a bang but an electronic whisper. And history recorded that "in 1987, the users of America executed the last of the professional data processors: the lone manager and his faithful programmer guide, Honto."

(The names Horace Van DerGuilt and Ray Honto are fictitious to protect the surviving relatives.)

Van Speybroeck teaches in the Business Computer Programming Department at Scott Community College, Bettendorf, Iowa. He is working on a book, Computer Science and Other Love Stories.

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END-USER DESIGNED/DRIVEN DATA BASES

By S. Atre

Who in an organization best understands the information needs of that organization? Who generates and uses the data and knows the relationships among data and the applications in which it is used? The users. But who designs the systems that handle the data? And who decides how the data is stored, maintained and retrieved? The DP staff.

How do we combine these two disjoint groups of employees for the benefit of the organization as a whole? Should the DP staff design the systems, even though the business expertise may reside in the user group? Should the DP staff perform the systems analysis; write program specifications; code, document and maintain the programs? What remedy exists, given today's recorded applications backlog (two to three years) and the invisible backlog of anywhere between five to seven years in most organizations? John Diebold has said that "The future of computing is in the hands of the user rather than that of

ILLUSTRATION BY BRUCE TURNER

End-User Designed/Driven Data Bases

the specialist. The computer programmer of 1985 will be the accountant, engineer and the planner."

Similarly, William Engle, editor of "Applications Software Reports," has stated, "With the immense growth of applications packages there will be a distinct shift away from the present reliance on highly technical people. More and more tools will be available to reduce the end-user's reliance on application programmers."

We in data processing have been complaining about the applications backlog. A major concern is the shortage of applications programmers. It is time for us to shift some of the responsibilities to the users — not just to get rid of those responsibilities, but because the users understand the company business. By user we mean the accountants, accounts receivable and accounts payable staff, planners, engineers, financiers, marketers and so on.

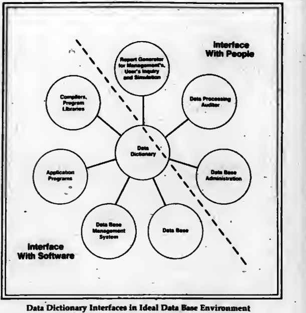
Within DP, the area of the data base seems to be the ideal and appropriate place to start this shift in responsibilities. This repository of information is the foundation of an enterprise's entire computer system. It is a collection of related data about an enterprise for which there are multiple uses. Designing and maintaining the data base are perhaps two of the most important areas in which users must be involved.

Data Base Design

The data base design process starts with the conceptual requirements of a number of users. These individual user requirements are integrated into a single community view, the conceptual model. The conceptual model represents the entities of an enterprise and the relationships between the entities. An entity is a person, place, thing, event or concept about which information is recorded. A relationship is an association, and the relationships are bidirectional.

If we consider the banking environment, one of the conceptual requirements could be that a specific customer (entity) has (relationship) many different accounts (entity). Another conceptual requirement could be that many customers (entity) have (relationship) a specific account type (entity) or a specific account type is used by many customers.

With the conceptual model, we can



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view all the data entities and their relationships to each other with no concern about their physical storage. The conceptual model is the inherent model of the enterprise; it is in this phase of designing the data base that we most need the users' help.

A good way to interest and involve users in early stages is to make them responsible, in part, for accepting the design. Obtaining their involvement is a human relations as well as a technical problem, and good communications at this time is essential. For years, many users have complained about the communication problem between DP and user departments, and a major hindrance to communication has been terminology. DP professionals must leave their veiled empire of technical jargon and understand the user's language.

On the other hand, users must take a hard look not only at current but also at long-range applications. They may now better appreciate the consequences of changing their minds later or of not taking the time initially to evaluate their needs thoroughly.

It has been estimated that about 60% of errors in new systems can be traced to omissions, inaccuracies or ambiguities in the specifications. Part of the communication problem is the gap between the sophistication of human language and the simple-mindedness of the data base. How can this communication gap be shortened — if not eliminated? A user-driven design of the data base could resolve some of the problems. Before exploring that issue further, let's look at how a data base is designed conventionally.

Conventional Design

The following scenario is typical of conventional data base design:

- The user expresses an urgent need for resolving a business problem. The user approaches the DP department.
- The systems analyst thinks he understands the user's needs and writes up the requirements specifications.
- The user approves the specifications, thinking the systems analyst did understand the business problem to be resolved.
- The applications programmer starts to write code. The applications programmer also prepares the test data, and the entire system is developed by the applications staff.
- However, before implementing the system in production, the user sees the reports or the output and at this time first realizes what is really needed.
- Changes and more changes are suggested. As a result, two factions are formed and an ever-running battle between the user group and DP flares up.

No one is creating the communications problems intentionally. In many instances, users don't necessarily know what they want. And the DP people think they understand the problems, when in reality they don't. If users could see the evolving process of data base design and could see what types of "views" they could receive, they would be in a better position to tell systems analysts what they really want.

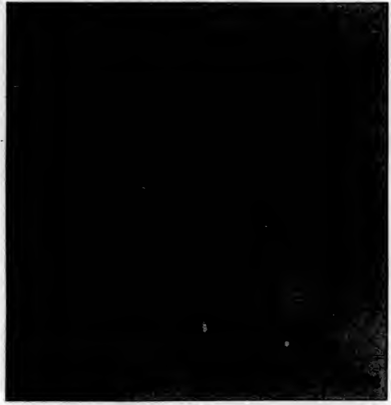
To realize the objectives of correct data, minimum redundancy and the best possible communication between users, a centralized control mechanism is mandatory. A data dictionary is a prime candidate that attempts to satisfy these requirements. It enables one to control and manage information about the data in the design, implementation, operation and expansion phases of a data base. The data dictionary stores information about data such as its origin, description, relationship to other data, usage, responsibility and format. It is a data base itself, which stores data about data. The data dictionary is a guide and contains road maps to the data base instead of raw data.

Dictionary Interfaces

The data dictionary has two major types of interfaces: one with the people involved and the other with the software involved (see figure on Page 62). With the help of a report generator (which would probably be an integral part of the data dictionary package), management and users are provided reports tailored to their individual needs. The report-generating capability can be extremely productive for the users in the maintenance phase.

The data dictionary can be very helpful to users in all phases of the data base system's life cycle. A number of different types of transactions can be stored in the data dictionary. The casual user seems to forget the procedural nature of the transactions. Provided a specific user is authorized to execute a specific type of transaction, the data dictionary can store that "proceduralness" of the transaction and relieve the user of the task of remembering the idiosyncracies of the procedure. The data dictionary can help the planner to answer what-if questions. The data dictionary should be the road map

About 60% of new-system errors can be traced to omissions, inaccuracies or ambiguities in specifications.



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that will take the user through the maze of the data base showing what data represents and in what applications it is used.

There are some advocates of complete user-designed and developed systems — with or without data base implementation. Because the users know what they want, they say, we should give them the proper tools (a relational data base package, perhaps) and send them on their way. This option is not a good one. Technical expertise is still needed. For example, hardware and software must still be compatible, proper testing must be done and interfaces to other systems must be considered. Objective views are needed. Users, emotionally tied to what they are currently doing and biased in favor of current needs rather than overall long-range goals, may want more than they actually need. Someone needs to ensure proper documentation. Therefore, the answer is neither complete user design nor complete DP design.

Life Cycle

The main phases of a data base system life cycle are:

- Feasibility Study.
- Design (Conceptual Model Design, Logical Model Design, Physical Model Design).
- Physical Creation.
- Conversion.
- Integration.
- Operations.

In most environments today, DP technical personnel are in charge from the earliest phase. It would be much more cost-effective to have a user in the driver's seat in the early phases of the data base system's life cycle. The users should be involved heavily in the feasibility study, conceptual model design and running the data base system in operations. That means the user should be the driving force during the design and computing (operations) phases.

One warning on implementing a system (physical creation to operations phases): Do not try to do it all at once. Divide the system into modules and set priorities based on user acceptance and visibility results, as well as on corporate needs. To sustain interest and commitment, users and management need to see results.

Data Base Operations

The operations phase, sometimes also called maintenance, is the time of most direct user involvement. Until recently, retrieval of information by a user was done via a request through the DP staff, specifically an applications programmer, and users were sometimes interrogated about why they needed the information. But requests far exceed the time and the number of programmers needed to process them. There is no overabundance of application programmers. Some thought the solution would be found by increasing programmer productivity through the use of structured programming, higher level languages and good initial design using prototypes. But even these tools were not adequate, and backlogs continue to grow.

Therefore, why not put some tools in the hands of the users and give them direct access to the data base (for ad hoc report generation) or allow them to have private data bases (for management support decisions, using a personal computer)? Out of ideas like these grew the concept of an information center. The information center would be in the business of providing information, as contrasted with the DP staff, whose business is managing information.

User-driven data base computing will alleviate some work by DP staff. The central data base is maintained and nurtured by DP technicians. Various user groups receive "their specific" data bases, which are extracted from the central data base. Users may read, update and delete pieces from their specific data bases. (Of course, not at random. Some mechanism is also required to handle security, privacy and so on for the specific-view data bases.) The specific-view data bases may also be accessible to various user groups if appropriate. The central version of the data base may be retrieved directly by the users, but not updated — unless clearance is given by the DP department. Users may perform updates to the specific data bases but not to the central data base. As a result of time lag in updating, discrepancies may exist between the contents of the nonupdated central data base and updated specific-view data bases, and this synchronization problem must be resolved. The specific-view generator is software created by the DP applications development staff, in consultation with the users, about the users' needs for the specific views. Ideally, the specific-view generator should be supplied by the data base management system (DBMS) package. The DBMS of the future may have that capability. The concept of specific views falls under the umbrella of information center.

"The proliferation of financial planning languages will create chaos throughout corporate management ranks. In the future, we will see one standard modeling language that extends from the personal desk-top computer to the central corporate information center."

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In addition to the information center, other means of providing users access to computers is through timesharing and microcomputers. With microcomputers, processing tends to become more and more decentralized, and careful checks on expanding uses and data redundancies need to be instituted. The Information Center, as originally conceived by IBM almost two years ago and initiated in-house by their Canadian installation, is a business within a business. It provides a service, which it must first sell. Its functions are to train users to use the tools of information retrieval and analysis. It is an interface between the user and the DP technical staff and the data.

Training should consist of computer basics, good manuals with no jargon and hands-on workshops. Hands-on training includes retrieval, updating, creating own screens and writing report-generation programs. Training data bases should be provided so that users are not intimidated by first working on the real system.

Marketing the information center to users may include things like sending out newsletters, holding open houses to introduce new tools and presenting various specific-view data bases. The center should be started with a few interested users who do not have to be sold and who can help spread the word.

The staff of the information center must have technical expertise (product and business knowledge). Perhaps more important, they must work well with people: They must be able to communicate and multithread and be patient, available, diplomatic and energetic. Former teachers seem to be good candidates for this function.

In the organization structure, the information center might be placed under the auspices of the director of applications development.

Applications development would be separated into those staffing the information center and the professional programmers. The information center itself should start small — perhaps with one consultant — but could eventually grow to need a manager, administration (to issue user IDs, prepare announcements and so on), a coordinator (with professional programmers) and consultants. It should be stressed that the consultant's job is not to do quick programming for the user. The consultant should help the user to evaluate needs; select the proper tools, such as ADRS, QBE or QBF in Ingres; and offer on-going guidance.

Very positive reports have come from companies that initiated information centers. For example, at one installation, the information center staff is 5% of the DP staff and that 5% is handling about 25% of the work load. Eleven information center workers support over 900 users.

Among the tools available to the user are:

- High-level languages that are becoming closer to pseudo-English, such as the query languages for relational data base systems and query languages built on top of systems using hierarchy and network models.
- Packaged applications, such as report writers (ADRS), text editors and formatters, forecasting programs, information retrieval, forecasting programs, accounting programs, presentation graphics and menu-driven software in general.
- For users of the specific data bases, Focus (Information Builders, Inc.), Ramis (Mathematica, Inc.), Culprit and Online English (Cullinane Database Systems, Inc.), Mapper (Sperry Univac), SQL/DS (IBM) and Nomad (National CSS, Inc.), just to name a few.
- In-house DP-built and user-built applications.

The information center is an effective way of increasing user involvement, but it is no magic cure-all. Many problems must be overcome. There may be resistance from the users themselves. In addition, the DP department may be afraid of losing control — part of its love-hate relationship with the data.

The best solution is to allow users, DP staff and the information center to create a community united in solving and overcoming these problems.‡

Atre is president of Atre International Consultants, Rye, N.Y. She was with IBM's Systems Research Institute for 14 years and wrote the best-selling book, Data Base *(John Wiley & Sons).*

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EXTRA

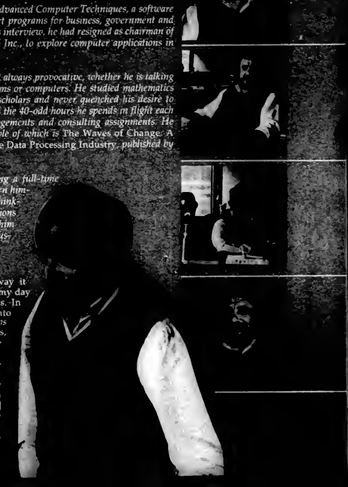
A CONVERSATION WITH Charly Lecht

Charles Philip Lecht came in wearing a beret and Carrera sunglasses, smiling, shaking hands and apologizing for being late; traffic had been heavy this morning. Thirty-two years earlier, Lecht had taken a train from Providence, R.I., to New York to find a job as a forklift operator. Today he tooled into the Big Apple from his country home in Connecticut in a BMW.

Twenty years ago, Lecht started Advanced Computer Techniques, a software firm specializing in state-of-the-art programs for business, government and the military. Two weeks before this interview, he had resigned as chairman of the board to found Lecht Sciences, Inc., to explore computer applications in biological research.

Lecht is thoughtful, perceptive and always provocative, whether he is talking about New York parking regulations or computers. He studied mathematics at Seattle University with Jesuit scholars and never quenched his desire to learn. He reads voraciously during the 40-odd hours he spends in flight each month traveling to speaking engagements and consulting assignments. He has written five books, most notable of which is The Waves of Change: A Techno-Economic Analysis of the Data Processing Industry, *published by McGraw-Hill in 1977.*

Free of the constraints of directing a full-time business, Lecht now plans to concern himself with writing, speaking and thinking about technological implications for the future. We talked with him about software, hardware, the industry and its future.



SOFTWARE

Let's talk about software the way it used to be: *software* software. In my day it was software and applications. In the 1960s it metamorphosed into *software* software and *applications* software. To the softwareniks, that was a different breed. In the latter half of the 1990s we'll have massive command and control centers at AT&T, IBM, American Express and Citibank, like the command control center in [Francis Ford Coppola's film] *THX 1138*, where software is the neuronal connection in a gigantic brain. In terms of applications

A Conversation With Charley Lecht

development, forget it. In the late 1980s and into the next decade, it will be done by business applications people, and the softwareniks will be relegated to special-purpose uses, to maintaining the old applications environment or to changing over to new environments. But no one will be writing applications in Cobol in 1990. Cobol has proven to be a lemon as a language, although it was the best lemon around in its time.

What will happen to programmers?

You know, that's really a good point. Programming came along as an incredible profession for a lot of people, including me. I've always wondered what I would have done had I not become a programmer. I came to New York to become a forklift operator, and I did become a forklift operator in 1951. It was by accident, really, that I discovered this neurologically satisfying activity called programming. Somebody must have devised this for people like me whose neuroses are capable of expression, not unlike people whose neuroses are expressed in music. I use "neurosis" in a very loose way here. When Rudolph Bing left the Metropolitan Opera he said he was sick and tired of making money from people who are able to work because they have a throat disorder, and it's in that sense I use the word neurosis.

I really believe programming is a very good professional opportunity in our lifetime for people in Cobol, RPG, Pascal or Jovial. I look at our lifetime in terms of my lifetime. I don't know how old you are, but I met a girl who was in her 20s and I said, "Didn't we talk many years ago?" She replied, "Not unless you were babysitting." So for our lifetimes, until the end of the century, because of the massive repositories of program libraries we have to operate, I don't see programmers or programming going away.

Will today's programmers be maintaining dinosaurs?

Maintaining, changing, evolving. I see a scenario: By 1987, IBM will announce for its information network service the capability to plug your 370-based application into a local-area network, which will communicate across the entire continental shelf. Your processor will be relegated to the graveyard shift to do Cobol processing. Everybody else will be writing their applications in English — or in algebra or Fortran in the scientific world. All the new data processors will be natural language.

What has prevented natural language from making its debut as the means through which people express computer applications is that computers don't have a powerful enough CPU or enough memory. Pascal is a good example of a language that is beautiful, highly usable and easily learned by computerniks. Except in the areas of high science or "software software," languages like Pascal or Ada will never see widespread usage. They are not English, and there are very few people who can really become good in algebra.

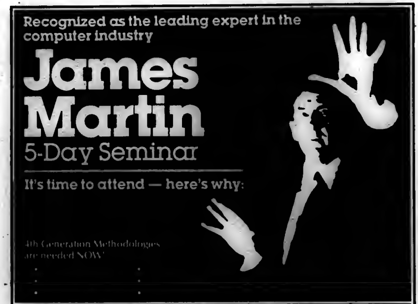
Pascal or Ada won't replace Cobol or anything like that?

No way! No way, no way. They're too complicated for widespread usage — the product of chauvinist intellectuals in the computer laboratories. Not all products of chauvinist intellectuals are bad, but Ada will always be used by only a small subset of people. An IBM Share/Guide report in 1978 identified our key inhibitor to growth in computer systems usage as shortages in trained personnel. This might have been restated as complexity of computer systems languages. Lessening the language problem means increasing numbers of people who can work with computers. Going from Cobol to Ada is like moving from Boston to New York to relieve big city problems.

Then it isn't just large investment in Cobol and the expense involved in changing over?

No! There is, however, a large library of applications — some say approaching $50 billion — in Cobol. It's said that approximately 80% of all programs currently in operation are in Cobol. This suggests that a person who knows Cobol today and doesn't mind doing maintenance will be secure as a Cobol programmer for the rest of his life.

Yet disengagement from Cobol is going to happen much more quickly than most people think. There has been a myth — perpetrated not by scheme but by ineptitude in the early days of the computer business — which says that somehow you were better off interposing a synthetic language between your own natural language and the language of the machine. In the folklore of computing, this interposition supposedly



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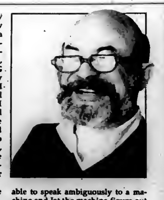
helped the machine to understand what you wanted and helped you to express it.

But not for new applications. It's a step back from computers to say, "I'm speaking directly to you, but I'm going to interpose somebody else. Then I'll speak to him, and he'll speak to you, and you'll speak to him and he'll speak to me."

Cobol has nothing in common with the way we speak or the way we do things. We are nonprocedural in our methods of operation; it's hard on a person who is having trouble enough expressing the application in English to then ask him to proceduralize the expression.

I've asked a lot of my lecture audiences over the past few years for alternatives to expressing an application in Cobol. Many like RPG because it is a nonprocedural language. It was an early 1960 language that died by 1968. Suddenly in 1973, everybody was implementing a new RPG on his computer. RPG's new popularity was coincident with a sudden surge in the widespread distribution of computer systems power. Minis were swelling in numbers, and micros were just beginning. RPG allows people to write the way they think, nonprocedurally. With RPG, I think a little about something, then I do it, then I come back to that and I want to do something that preceded what I thought last time. Now I come back two weeks later and I can add another line, and they don't have to be in order. Cobol, Fortran, PL/I, Pascal, C — everything has to be done procedurally. And you know — we are not robots. We don't think or behave procedurally.

The clue is that we want a language in which we can express our application in the most natural way, and that language is English for those who speak English. You should be



able to speak ambiguously to a machine and let the machine figure out what you meant, then straighten out your ambiguity.

HARDWARE

HAL [In the Stanley Kubrick film, "2001: A Space Odyssey"] was a very realistic computer. It's where we are going: a bank of devices all running the same program at the same time. That's why the concept of the tandem software environment is a seedling that indicates the future structure of machines — a bank of processors all helping one another and, at the same time, doing the same thing.

I think that what we'll see long before the end of the decade are larger banks of numerous processors. You'll say, "I want to create a general ledger, computer." It'll say, "All right, tell me a little bit about what you want to do." You'll say, "I think the column headings for my general ledger should be the following: dah-dah, dah-dah." The computer will reply, "I understand."

That will be stored and, partly by algorithm, partly by brute force, the process of creating a program will involve a dialog with a virtual superhuman-like being you can talk to. The systems processors will then talk to one another. They'll put the program together and give it back to you. That's the ultimate.

What do you see in store for the personal computer?

Most companies are going to give them away. Right now, the large insurance companies in New York are giving them away to their agents, who do the data entry for the insurance company. Chemical Bank is giving them to their largest accounts. The Atari 800 attached to a TV set is capable of retrieving your financial status from the bank.

All of the services available on a computer are being readied now by NBC, CBS, American Express, Chemical Bank, Citibank, IBM and AT&T. All of them have the economy of scale to invest in enormously sophisticated entertainment and games and download everything — all the arithmetic computations, data storage and retrieval, liquor by the drink and so on. Now what do you want a personal computer for?

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ness. You'll notice that Burroughs, Univac, Honeywell and Control Data haven't entered with very much either. There is little or no profit in the little devices unless you get a heck of a lot of them out there. It's like the terminal business. Unless you've got a built-in customer for their usage, it's a Waterloo. I'm certain IBM sees personal computers as terminals to their networked services. However, people do not view them this way yet

INDUSTRY

What about Japanese competition?

It's my theory that what IBM does, Japan will do and what Japan does, IBM will do. In Japan they say my contribution to the technology was to put all large Japanese companies on the IBM business plan. Japanese wisdom says that in the absence of a clear plan, following the leader is most efficient.

I once met a Japanese scientist, Yuki Takeda, who was very unusual. I just loved this man. He read the "Tsunamai" article in *Computerworld* [May 5, 1979] and called me to talk about it. At one point I told him, "I just do not understand Japanese people. Over a period of time my attitude has changed from negative to wounded to just not understanding. I've gone into a well of ignorance." He promised to discuss it with me.

When he came to New York, I looked at him and said, "Tell me, what am I doing wrong? Every time I go to Japan I fail, yet I have friends like you."

"Your mistake, Charley," he said, "is trying to understand the Japanese mind. You come to Japan a few weeks a year and you want to understand us. We have been in Japan thousands of years and *we* don't understand the Japanese mind. But one thing I can promise you: We understand your minds better than you understand ours. We are constantly dealing with foreigners. International trade is our whole life." So I said, "You mean go there and be myself." "Yes," he said, "you should go there and be your New York self. We will understand where you come from."

All right, I thought. That spring [1979] I had a speech in Tokyo for Jeida [Japan Electronic Industrial Development Agency]. I decided I was going to act like myself. Maybe I would not be invited back. But I lectured as though I were speaking to Americans, and I finally had a successful business trip to Japan. I started to understand them and concluded they are wonderful people. It only took me 10 years.

We have a global market today, and it is unfolding faster than it is able to be serviced. I think IBM recognizes this. Its global market is dropping fairly rapidly — not as fast as some of its competitors would like — more by the unfolding nature of the marketplace than any failing of its products. I think IBM is the best America has to offer. Its success is the result of good hard two-fisted American capitalism. And the proof of this is in our de facto IBM standard; 80% of the world is on it.

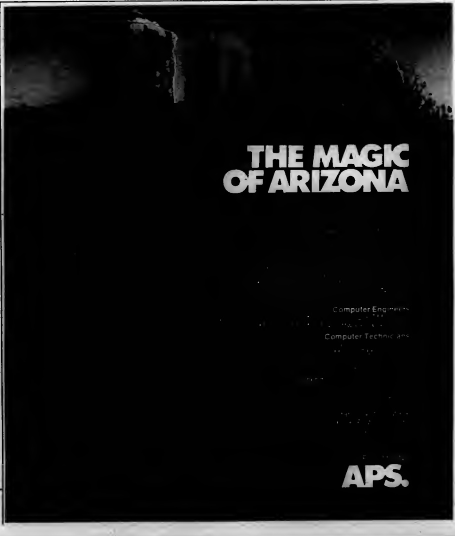
IBM's success is the result of good hard two-fisted American capitalism.

As a result of this, I see a movement away from head-on competition with IBM. Does this mean Honeywell, for example, is going out of the general-purpose computer business as we know it? Yes, but so is everyone else. As IBM, AT&T and others build their massive service centers to distribute computer systems power like telephone service, Honeywell, Burroughs and the rest will start to address very vertical marketplaces. That means that IBM and the IBM code-compatible machines all have a very bright future.

There's another scenario: Charley Lecht says that massive networks will provide 90% of the DP power in America in the second half of the decade, and few will know whose or what kind of processor their applications are being run on. So product loyalty to IBM, DEC or Data General vanishes. That opens up a whole new ball game. Like with your telephone, you won't need the hand holding any more. This could stimulate production in places like Univac, Burroughs, Honeywell and Control Data to vitiate their opponent, IBM. I'm not positive which direction it will go. At first, it may spirit competition, but a movement from product loyalty to system loyalty will occur. When that happens, it opens up the doors again for all of these high-tech firms to flood the place with cheaper alternatives.

Those are the two arguments. When you plug your keyboard into a modular wall plug the way you now plug in a telephone, and you ship a program, you won't know where it's going to be run. It could be run on a 370, a 3381 or a VAX. When you stop knowing where it's going to be run, you stop caring about the name of what's running it.

That's the scenario I see by 1990. I see a short-term aversion to purchase away from the IBM plug-compatible or IBM code-compatible product lines, then a movement back to utility systems, whose origins are unknown. Parallels exist in every other business in America. We used to talk about "don't go" something or other in Delco

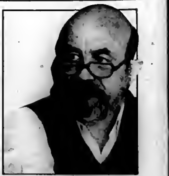


auto parts or something. At one time, people bought electric generators by brand name. Do you care now if it's Con Edison or not? Most people don't care anymore.

I think the opportunity to put applications in the networks will be unending for people who can conceive of these in a competitive way and be friends with the networks. Now you say, wait a minute, Charley, are you saying there will be no computers in companies, just Swiss cheese templates in the wall into which people plug devices? Absolutely not. Just as there aren't generators only in public utilities, I foresee a whole hierarchical spectrum in the 1990s that includes massive amounts of power coming into the network from the corporate computer facilities. Some will come from client facilities of a company and some will come from some very vertical, special-purpose repositories of hardware and software. I see a mix, and I think that's only rational because it confirms everything outside my New York window. There is nothing all here nor all there. But I see tremendous benefits to the emergence of national networks, in the economies of scale these offer in the delivery of computer facilities that do many things for people. It's just tremendous.

Does deregulating AT&T figure into this scenario?

I feel it was a resounding defeat for the Justice Department when it "settled" with AT&T, but it came as no surprise. What was surprising was that, once having been defeated by AT&T, the government acted as though it was a victor and beneficently dropped the case against IBM. Well, what the hell does the case against IBM have to do with AT&T?



They were both Justice Department cases, and that was the only thing they had in common.

The one against IBM had to do with the questionable business practices of a competing company. The other one had to do with the same, but for a monopoly. There was obviously merit to both cases. But times changed, and the cases grew stale. There's no question about it.

In all honesty, there are several mysteries I hope are revealed to me before I die. One is how a country can create as powerful a monopoly as AT&T on the one hand and then expect an elected or even hired governing arm in Washington to tell that thing what to do. I have trouble reconciling that. I can't see a chairman of the Federal Communications Commission who was not acceptable to AT&T staying very long. It is not because he would do anything wrong; I think that in our competitive environment it is considered absolutely correct to get rid of the competition. How do you get rid of it? Through the massive power a monopoly can muster. Public relations campaigns, for example, are best carried out by large corporations.

I think both AT&T and the Justice Department were sincere. Both thought they were right, and the government had to lose out. Why was the case against IBM dropped? It had nothing to do with the AT&T case. This suggested to me that the U.S. government was having problems telling IBM and AT&T apart. They couldn't tell who was Tweedledum and who was Tweedledee. I'm serious.

Charlie Brown said it himself: "There was merit to our case, but it would have taken too long." I believe him. In IBM's case, it was already 13 years, and they were just about ready to go to trial. What did that have to do with dropping IBM? Ultimately, it was that if they had dropped the case against AT&T and left the one against IBM, AT&T would be the only technology industry in America, with no competition at all.

There is something we never figured out how to deal with. First, in our society we encourage a company to be as successful as it can, grow as large as it can and do everything that's required to make it happen. Then when it gets there, we say, "We're sueing you for having won." I don't see this as a base conspiracy. It took me many years to figure out that

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my enemy was as unplanned and disorganized as I was. The enemy is us.

THE FUTURE

How do you perceive the future of high technology?

First, to improve the quality of our lives, we need all the high technology we can get. It's unquestionable that computer and communications systems have done just that. Relieving toil and drudgery in factories, eliminating white-collar inanity, now extending man's natural faculties of memory, logic and computation. What the lever was to the body, these systems are to the mind. Improvements in high tech bring improvements in every aspect of our functioning. We can go places without moving. We can see what isn't in our vision; learn about the cosmos and microcosmos; improve our physiques, our minds. I hope the long-term future will see us bringing this technology into ourselves and using it to pole vault out of the chaotic world we live in. For example, maybe we'll discover why the imbalance between supply and demand exists, fix it and live in peace. I hope beyond hope that technology will provide us with better vision, logic, memory and so on.

I keep hoping that artificial intelligence might augment the real stuff and help bring us some explanation for things that are otherwise mysteries. By implanting a good artificial memory — because the natural one doesn't remember anything — or implanting artificial logic and arithmetic abilities, I think most of us could become real sweethearts. Alexander Solzhenitzen made the commencement speech at Harvard in 1979. In it he told how disappointed he was to learn that the failings in the totalitarian society he came from weren't cured in our democracy. Not to say we aren't an improvement, but profound ignorance wasn't the privileged commodity of either.

Improvement is something to help us realize our dreams, mainly living in peace and harmony without harming others or fighting over the supply-and-demand equation. I see no virtue in unhappiness, in toil. That's a litany meant to make you feel better while you swallow the pill, so to speak. My dream is that with hardware and software systems, and the evolution of these systems as we see them today,. we can improve the quality of life.

I can see large-scale integration [LSI] chips now that mobilize the immunization system before the body's immunization system can do so, because the body's system isn't that good. Ultimately — and I don't think it's science fiction — I believe a cure for cancer has a good chance of coming from the computer industry, rather than from medicine.

The geneticist, the biologist and the medical man are all trained in the envelope they would like to assay; a paradox if I ever saw one. We need to find new ways to find cures. Producing cell-size LSI might help. Imagine compressing the continental shelf down to the size of today's networks which span a molecule or a cell. And if the logic and memory were made of organic material and we could create the I/O channels needed to communicate with a cell, we could read its memory — run its program. We might then learn its mysteries: how to regenerate, grow life and improve our species. Cells have memory; they are little computing devices. They always remember how to make a person, and they do it all the time. The program operating in there — the memory that tells the cell to make a person rather than a tree — is the program we want to run and the memory we want to access. If we did that, we might have a cure for cancer, the black hole of medical science. Regeneration instead of degeneration must be our goal.

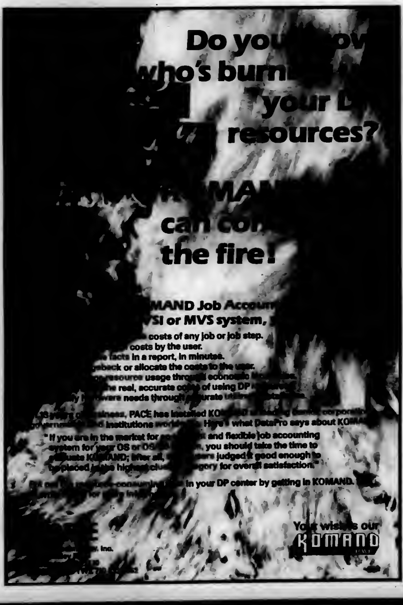
And what about your own future?

After 20 years of corporate problems, it's nice to have more freedom. I want to write and do research and lecture. I've already spoken in San Francisco, Hawaii, Dallas, Saskatchewan, Johannesburg, Rome and Washington this year. I want to relate computer and communications technologies to the forefront of science.

What does the forefront mean? To do research in bionic devices, to look into the use of LSI for disabled people. I want to write, to explore and to do actual experimentation.

I want to ascertain the validity of new concepts, such as protein computing devices. With a few colleagues, I have created a new think tank. I hope we'll contribute something important. I'm hell-bent for leather to do so, but if I don't, it won't be because I didn't try. Minimally, it will have been a nice diversion while I'm completing my tour of this planet.

> ***My dream is that with hardware and software systems, we can improve the quality of life.***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(Continued from Page 36)

package implemented more than 60% of the required data entities in its logical data model. The company found it was consequently cheaper to develop an in-house system than to select and modify a package.

- The data model provides an interface between otherwise incompatible application packages and DBMS products. One organization uses the data model as an interface between a centralized Adabas system and multiple remote System/38s. Another organization uses it to interface separate IMS, Total and IDMS application systems.
- After data use analysis (see below), logical performance can be predicted for comparison with user requirements. Appropriate software, DBMS, packages, hardware, system distribution and network structures then can be selected.
- The procedure models can be used for selection of appropriate implementation languages: production languages such as Cobol or PL/1 for high-volume applications; end-user languages such as Focus, Ramis or Nomad for low-volume applications; or still other languages for minis or micros.
- Part of the data models and procedures may be physically implemented on production DP systems. Part may be implemented on separate systems for the information center. Part may be implemented on distributed minis or micros. Some may not be suitable for any automation.
- Because these logical models are technology-independent, DP, with minimum impact on the business, can take advantage of new hardware, communications, DBMS products, languages and application packages as they become available.
- Similarly, business change can be accommodated more readily, with minimum impact on data bases and programs. Because of the focus on the future, many strategic alternatives have already been considered, and the data models and procedure models have been designed for change. Most of the essential data has already been identified and implemented. More responsive DBMS products and languages (which can easily accommodate change) have been utilized.

The DP department thus changes from being reactive to being proactive. Instead of being buffeted by business change, DP can respond readily to new business needs. The data bases and systems have been designed by users and DP together — for the future, to be able to change rapidly when required.

Performance optimization of data bases and systems is the technical specialist role of DP in this environment. The DP-driven information engineering methods of data analysis and data base design (see Figure 1 on Page 32) assist here.

Data Analysis

This DP-driven approach is used primarily by analysts to develop third normal form data models based on current systems for optimum performance of response-critical transactions.

Source documents, reports, enquiries, files and ledgers of current manual and automated systems are used to identify data attributes and entities. These are normalized and documented as third normal form data models. These current data models provide a cross check for future data models developed through information analysis.

Is data in the current data model also needed in the future data model? This defines a migration path to the new systems. Does the future data model include new data not found in the current data model? Is it in fact new data, or did we overlook it in developing the current data model? Is it serving a new requirement?

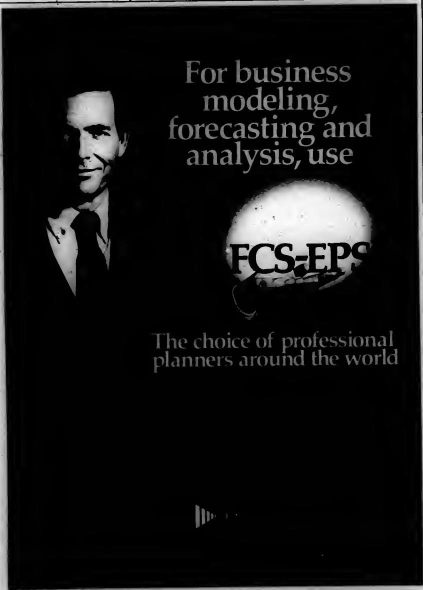
Does the current data model include data not identified also in the future data model? During information analysis, did we fail to involve people with knowledge of that data? Or is the data needed in the past, but not required for the future?

Often in our new systems, we include data that "has always been there." Its true purpose in the organization has been lost in antiquity. The strategic directions upon which information engineering is based clearly indicate data's use for the future.

Data Use Analysis

The procedure models (from procedure formation) define logical procedure usage paths in referencing data model entities via relationships. The relationships between entities can be quantified by DP as frequencies of occurrence.

A CUSTOMER may have an average of five ORDER entities (that is, five orders outstanding). An ORDER may comprise an average of five ORDER-PRODUCT entities (see Figure 3). These frequencies of occurrence may be used by DP to calculate logi-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cal entity references for a procedure. This is the information engineering method of data use analysis.

For example, a procedure based on a customer enquiry of all outstanding orders (in Figure 3) would involve a total of 31 logical entity references. (One reference to CUSTOMER; five references for all ORDER entities; 25 references for all ORDER-PRODUCT entities for each of the five ORDER entities.)

In conjunction with a physical design for data base implementation, an empirical estimate can be made of likely (processing) response time. For example, if each entity was physically implemented as separate unblocked files, a logical reference may be implemented as a physical I/O access — perhaps 100 msec. Thus, 31 logical references result in 31 I/O accesses, which suggests a processing time of three seconds.

Is this within the user'a response time requirements? If not, the transaction may be response-critical if implemented with that physical data base design. The physical design can consequently be adjusted before implementation or even before DBMS selection.

Data Base Design

Data use analysis provides input to data base design. If the DBMS supports physical grouping of logically related records, the ORDER-PRODUCT records for each ORDER record may be grouped together in the same physical I/O block. Thua, the above 31 logical references for a customer order enquiry would result in only six I/O accesses and 25 storage buffer accesses. The processing time would be less than one second, rather than more than three seconds.

Data base design uses the logical data models (from information analysis and/or data analysis) in conjunction with the logical procedure models (from procedure formation) to design optimized physical data bases that benefit from the architecture and characteristics of each DBMS product. Data base design is DBMS-independent and is used for physical design and implementation of centralized and distributed data bases using any of today's conventional or relational DBMS products.

These data bases are performance-optimized for response-critical transactions and along highly referenced usage paths. They can be easily migrated to new DBMS products or to relational data bases as they become available.

In discussing the user-driven and DP-driven methods of information engineering above, I have emphasized the main results that emerge from the design partnership between users and management. I will now relate these techniques to BSP and to software engineering.

Business Systems Planning

BSP has been used very effectively by IBM and certain management consultants as a way to involve senior management directly in defining future information system directions in their organizations. The results have been impressive. Management has been able to see the benefits of information systems more closely attuned to their strategic directions.

However, the promise has sometimes been greater than the reality. The implementation of those information systems has been difficult. BSP does not provide detailed methodologies for implementation as data bases and systems. The many Share and Guide projects addressing this problem — sometimes called "life after BSP" — reflect the concern of many organizations for BSP implementation techniques.

Although some BSP projects have been spectacularly successful when implemented, that success was often due to the force and experience of a few gifted data base administrators rather than to BSP.

But the greatest problem with BSP has been the squandering of valuable management time in interviews. That same time can be more productively used in evaluating active feedback to management of the new strategic alternatives identified through information analysis and procedure formation.

These techniques, in conjunction with strategic planning, can start at a point higher than BSP and with a longer planning horizon addressing not only DP systems, but also the organization outside DP. They lead to exact implementation of data bases and systems much more quickly and completely than by interfacing BSP to software engineering.

Case Examples

For example, in only eight weeks, one major U.S. corporation developed a broad corporate data model across the whole organization. Two senior users and one senior data administrator were involved full time, and a third user was involved part time. The data model comprised over 90 data entities and approximately

Management finds information engineering more attuned to strategic directions.

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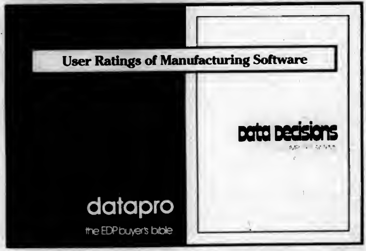

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800 data attributes. It provided a framework for the establishment of an information systems architecture and more detailed data models in major divisions. Invaluable refinement of business plans occurred concurrently.

Another multinational developed a corporate data model, oriented to marketing, concurrently across its Canadian, Australian and German companies. In a little over three months, strategic plans had been established and a major portion of the modeling had concurrently been completed.

Following this project, the president initiated a corporatewide productivity improvement project using information analysis and procedure formation. These are being used primarily as management techniques. They allow rapid review of how the business should be run, for comparison with the current environment. As a by-product, they will provide integrated computer support systems for management.

Yet another organization (a manufacturer) developed a detailed corporate data model in three months, using three senior managers 25% of their time, together with two analysts.

This corporate data model comprised 110 entities and 1,600 attributes. It provided input to procedure formation, based on users closer to the operational part of the business. In two months, they derived an average of 60 procedures in each of the six application areas of the business. They documented these procedures as procedure models, providing an exact specification of requirement to DP. DP converted these procedure models to transaction program specifications in structured English at the rate of four transactions daily.

Through the approach used in procedure formation, these program specs automatically exhibited high functional cohesiveness. (The need for structured analysis and structured design had been bypassed because of the users' involvement in analysis and design with information analysis and procedure formation.)

DP then coded these transactions in Cobol — coded, tested and documented. The average transaction took two days. None was longer than three days, and some took only one day. This was more than an order of magnitude greater productivity improvement over traditional development. The reasons, as stated above, were:

- Senior management drew on its business knowledge and information analysis to design a corporate data model that addressed its strategies for the future. Management progressively refined those strategies based on immediate feedback obtained through information analysis. ("It was the first time we have been able to clearly see the information we need to run the business.")
- Users derived procedures from that data model which directly addressed the strategic directions and objectives set by management. Procedure formation enabled them to take a fresh perspective for the future and identify procedural improvements. (For example, the organization described above is the one that identified nine procedures for receiving goods into inventory. They developed one standard procedure.)
- The data model and procedures provided an exact requirements specification for precise implementation by DP. This was developed above in one-half the time of a traditional specification, yet was more complete and unambiguous. Furthermore, about 60% of analysis and design had already been completed by the users before DP became fully involved.
- Subsequent data base design and implementation by DP was many times faster than previous approaches. Management had already completed much of the design in the corporate data model and associated entity list (a detailed list of entities, attributes and primary and secondary keys which defined the data base record formats for DP).
- Transaction program specifications (which were developed by DP from the procedure models at the rate of four transactions daily) were comprehensive, in structured English, with high functional cohesiveness and ready for coding.
- The common modules, also identified through procedure formation, were coded, tested and documented only once and then incorporated in all transactions that used them. The result was a rate of program implementation and testing in Cobol and many times faster than software engineering (depending on transaction complexity).
- Although not all the results relating to subsequent maintenance are in yet, indications are that maintenance is significantly less than traditionally encountered with software

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engineering. The expectation is that this reduction will result eventually in systems that have only a fraction of the maintenance work load of previous techniques.

Software Engineering

At appropriate points above, I have indicated the relationship between information engineering and software engineering. It should be evident to the reader that information engineering can start at a point considerably higher in the organization than software engineering and also higher than BSP. Information engineering enables data bases and systems to be developed top-down in detail, through an active design partnership between management, users and DP.

Because of the results of this design partnership, the need for structured analysis and structured design is bypassed.

The result is the production of structured code driven from management objectives. The problem of transition from structured analysis to structured design disappears.

Moreover, information engineering provides a path not only for structured coding, but also for nonprocedural languages (in the information center), and for distribution analysis and data base design. Automated data modeling tools may be utilized (or bypassed if desired) and the use of data dictionaries and design dictionaries (automated or manual).

Some organizations that have standardized on software engineering have first introduced the user-driven methods (of strategic planning, information analysis and procedure formation) for development of requirements specifications for new systems or redevelopment of current systems. They have used software engineering in DP in conjunction with the DP-driven methods of data analysis and data base design to design migration paths to those new systems.

In one case, an organization decided the software engineering phase was unnecessary. They determined it would dramatically slow down development in their environment. Through information engineering, they had already moved to much higher development productivity than they had achieved previously with software engineering.

Other organizations have chosen to introduce information engineering first with their information center to ensure its success. When the underlying production DP systems come up for redevelopment, they project down through the information center data models into production system redevelopment detail using information engineering. These new production systems then directly drive the information center data bases (rather than provide periodic data extracts).

Most organizations that have used both information engineering and software engineering acknowledge that they are progressively making the transition to an environment of greater user and management involvement in design and implementation of systems. While software engineering was right for the 1970s, they believe information engineering will enable them to move to the greater productivity essential for the 1980s. The results seem to support that assessment.

Project Management

With firm, committed consulting support, an initial high-level pass through information analysis and procedure formation can produce a broad corporate data model — and broad procedure models of major systems — in a total elapsed time of three months. These broad models can be used to establish an information systems architecture:

- They establish a framework for corporate information resource management.
- They enable appropriate implementation strategies to be established (centralized, distributed, conventional DBMS, relational DBMS, fourth-generation languages, application packages and so on).
- They provide an implementation architecture for the information center.
- They provide immediate feedback to senior management for refinement of strategic directions based on these broad models.

This comprises part of a feasibility report, which is delivered to senior management by the information engineering project team, together with broad data and procedure models. These identify feasible alternatives based on strategic directions established by management. New business and DP opportunities identified during this three-month study are also documented. The result is the firm establishment of a corporate information architecture, which can be used as the framework for progressive implementation of detailed information engineering projects

Information engineering can start at a point considerably higher in the organization than software engineering.

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throughout the organization. A subsequent detailed information engineering project may then take two to six months in the user-design stages. The previously developed corporate information architecture framework enables these projects to be firmly scoped for completion in this time period.

Each project then applies information analysis and procedure formation in place of the traditional requirements specification and feasibility study. These techniques expand relevant sections of the broad models into functional area project implementation detail. A large proportion of the analysis and design previously done wholly by DP is thus completed by users, management and DP representatives of each functional area project team. This also completes much of the logical data base design previously carried out by data base administration staff. It leaves them free to concentrate on the physical data base design.

During application of information analysis and procedure formation, the data resource is clearly defined for input to a data dictionary. Most projects can then be scoped for completion — from start to finish, including design, coding and installation — over a total period of nine to 12 months. This ensures progressive cutover of critical areas of the organization, while less critical areas may be left for later implementation. It should be recognized that achievement of broad corporate model completion in three months and progressive functional area cutover in nine to 12 months assumes strong project management. Subsequent implementation may be completed by users with high-level end-user languages an order of magnitude faster than conventional languages. Using Cobol, DP implementation is many times faster than generally achieved with software engineering.

Summary

The results of the information engineering design partnership between users, management and DP to date are impressive. In summary:

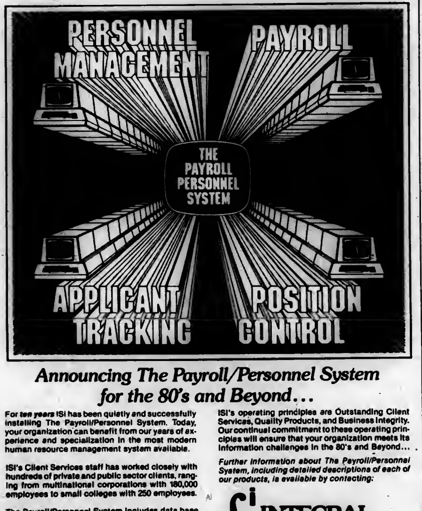
- With effective project management, information analysis and procedure formation proceed several times faster than a traditional requirements specification and feasibility study.
- New business opportunities are identified for greater return on investment.
- Immediate feedback is available to management for refinement of strategic directions.
- These techniques enable users themselves to complete much of the analysis and design previously done by DP.
- Most of the logical data design is also completed by users during this period.
- Physical data base design by data base administrator staff is then significantly faster than with previous methods.
- Data is progressively identified by users and management for input to a data dictionary.
- Low-volume applications can be implemented directly by users in the information center an order of magnitude faster than DP, using high-level end-user languages.
- High-volume applications can be implemented by DP (using Cobol or PL/I) many times faster than traditional structured development techniques.
- A library of common modules with high functional cohesiveness is developed as a by-product of implementation, resulting in even greater productivity.
- Subsequent maintenance is substantially less than with previous application development techniques.
- The application backlog is reduced dramatically — through direct analysis, design and implementation by users.
- Existing DP analyst and programmer resources can be used to support a greater number of concurrent development projects over a wider range of users.

The techniques used in information engineering are formal, precise and business-oriented. They are changing the art of analysis, design and implementation to an exact science.

They open the door now to computer-aided design and computer-aided manufacture of systems. Eventually, they will lead to computer-aided corporate design and the automated generation of all required computer support systems.

Adapted from the forthcoming Prentice-Hall book, Information Engineering, *by James Martin and Clive Finkelstein.*

Finkelstein is chairman of the board of Information Methods (USA) Corp., Waltham, Mass. He founded Information Engineering Pty. Ltd. in Australia and New Zealand and first wrote about this new methodology in a six-part "In Depth" series in Computerworld *(May 11-June 15, 1981).*



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Computerworld Round Table

(Continued from Page 19)

tion center is evolving and I think it's a question of using some later languages, some more user-friendly products. I like integrating the personal computer into it more so that certain things can be done right at the workstation and it does not have to go into a mainframe to get the job done.

Crandall: Let me just clarify my statement. When I said the information center was ahead of its time, I was talking about the information center a la IBM specifications, including the products which it intends to use. I was focusing on the products and not on the user support function of the information center, which has been sorely needed and absolutely should be there. The IBM information center has a list of 40 or 50 products out of their available library of software. So it is not like IBM came up with a concept of the information center and then went about designing software for it.

How do you handle training within your organization? Do you have a formal training program?

Allard: A few years ago I decided to experiment. We worked out a deal where we took one opening and converted it into two training spots. I call it my two-for-one program. After about two years of training, if these people make it, they become permanent. Our success rate is about 50%. We have had a lot of stability in the organization — virtually no turnover. That's why, when I have more requirements than I can meet with my people, I will generally use contract programmers to fill in rather than try to hire.

Is it difficult to find experienced DP professionals?

Allard: It's like joining the queue with every other company in New York. You may only get one once in a while.

McClure: We used to try to solve this problem by taking technical people and educating them, like the application programmer. He understands that particular area, but above all he has technical skills. Now we have come full circle and are taking specialists in our organization — applications people and users — and also giving them some level of technical expertise so they can use the computer as a tool.

If you look at educational programs in universities, in business schools, for example, they are picking up that notion that MBAs have specialties and they also have technical expertise.

Allard: I agree with this whole idea. When it comes to our information center, what I'm basically looking for is some bright people that can work and get along well with my users. I would rather go lighter on the technical side. They need those interpersonal skills. Where you get into problems is where the technical people aren't compatible with the users.

I see the users as my customers. I like to think that the users' perception is the reality of my business. If I think I can build the greatest systems in the world and *they* don't think they are any good, then those systems really aren't any good. On the other hand, if some of the systems aren't so good, but the users think they're good, the systems are great.

It seems that what we have been talking about, in one sense, is the need for a different role for the DP manager.

Allard: I tend to think of myself as really a businessman and make my role in U.S. Trust as I would run a business. I have a $6 million budget and a lot of customers out there, and I've got to try to keep them happy. What I do all day long is solve problems and make decisions. I'm basically in the business of managing people.

How have you managed to achieve such a low turnover in your DP installation:

Allard: One way is to move people around so they get exposure to all the training areas. But also I think a lot of it is the fact that people know something will get done. If they start on something, it is going to get finished.

I also work people hard. I've found I never lose anybody when they're working hard. You lose them after they finish working hard and they have time to think about how they were so misused when they were working hard.

I do think, though, that the worst thing you can do is to put people in a situation where they're overwhelmed. People have got to be continually challenged, they've got to have reasonably tight deadlines and they've got to keep moving.

McClure: One of the differences I see and hear when I listen to Joe is

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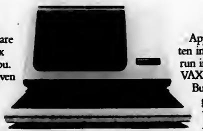

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that he sounds very much like part of management. He says the things that I would expect to hear from a manager — bottom line, what can I do that would be most cost-effective and can be delivered on time. Those aren't terms you commonly hear from DP management. They've usually been kept separate from management in the rest of the organization in terms of their ability to understand where the organization as a whole is going, what the priorities are, understanding business terminology and what makes the business run — and there has been a communications problem.

Crandall: I think the DP manager could change his self-perception from being the development organization to being the systems and user support organization Then he can basically match needs with supply and make an objective make-or-buy decision, for instance, although there is obviously a gray area where the user says, I need specifically this and I won't bend an inch. I think there is a bit of a diplomatic function that the DP manager has to see if he can bend that person off the extreme a little bit.

Does it seem that DP managers have to develop more of a general management role?

Crandall: Even the name, DP manager, is so much oriented toward the nuts and bolts rather than problem solving. And now you have the MIS-department, which is a problem-solving kind of organization that in some companies is the one serving the end users. You have many organizations, but, call them what you will, somebody has to run the computers.

What I think we are talking about here is the organization that thinks of the rest of the corporation as users, clients. That's responding to problem solving. In that regard, even calling it a DP organization is a strike against it, because it's a *user problem-solving organization*. You can think of it more in terms of closeness with the user and participation with what the user is doing. It is going to be difficult for these individuals today, staffed with DP positions, to become that person. It's a different set of communication capabilities and, possibly, academic training.

Is that a key to optimizing resources — changing the nature of those resources?

Crandall: The key to optimizing resources is to meet the priorities of the users. That is productivity.

Allard: I'm banking on this. We are hiring people now. Technical skills are important, but they must have the interpersonal skills. That wasn't true two years ago. I used to think that if a guy was a good technician I would put him in a closet. My closet is full. I've got to have people who can talk to my users. I refuse to hire somebody otherwise.

McClure: I couldn't agree with you more.

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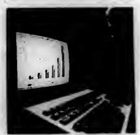

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